

Unit One: Climate Change and Development Challenges

Core Unit

Unit Information	3
Unit Overview	3
Unit Aims	3
Unit Learning Outcomes	3
Unit Interdependencies	3
Key Readings	4
Further Readings	6
References	9
Multimedia	12
1.0 Climate change and development: the challenges of our time	13
Section Overview	13
Section Learning Outcomes	13
1.1 Climate change challenges	13
1.2 Development challenges	17
1.3 Climate change and development interactions	22
Section 1 Self Assessment Questions	26
2.0 Short histories of development and climate change policies	28
Section Overview	28
Section Learning Outcomes	28
2.1 A brief history of development policy	28
2.2 A brief history of climate change policy	30
Section 2 Self Assessment Questions	34
3.0 Conceptualising climate change and development problems	36
Section Overview	36
Section Learning Outcomes	36
3.1 Conceptualising climate change and development problems	36
3.2 Climate change and development as 'wicked', complex problems	42
3.3 Addressing complex, 'wicked' problems	44
Section 3 Self Assessment Questions	46

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4.0 Responding to climate change	47
Section Overview	47
Section Learning Outcomes	47
4.1 Mitigation and adaptation: the basic concepts	47
4.2 Linking mitigation and adaptation	48
4.3 Secondary and indirect impacts of climate change and climate change responses	52
4.4 Political, lifestyle, and system interactions in climate change policy	54
Section 4 Self Assessment Questions	56
Unit Summary	58
Unit Self Assessment Questions	59
Key Terms and Concepts	60

UNIT INFORMATION

Unit Overview

This unit introduces 'Climate Change and Development'. Tackling climate change and achieving development are, individually, the two major challenges facing the world. They are, however, also intimately related: failure to tackle climate change will have disastrous effects on development, while development processes are major determinants of global climate change responses. Section 1 sets out the scale and importance of the challenges posed by climate change and underdevelopment, and is followed, in Section 2, by a brief history of global efforts to address these problems. Section 3 then outlines ways of conceptualising critical features of climate change and development processes and examines the nature of the problems posed in climate change and development, asking what it is that makes them particularly difficult to address. The unit concludes with a brief introduction of the different approaches followed in responding to climate change.

Unit Aims

- To set out the importance of climate change and development as independent topics, and in their interrelations.
- To define climate change and development.
- To explain the nature of the particular challenges posed by climate change and development, independently and together.
- To introduce the basic types of response that may be made to climate change challenges.

Unit Learning Outcomes

By the end of this unit, students should be able to:

- explain what the terms 'climate change' and 'development' describe
- review the scale of problems posed by climate change and development and how they interact
- explain why the problems posed by climate change and development are particularly difficult to address
- critically discuss major interactions between mitigation and adaptation as the two major basic forms of response to climate change challenges

Unit Interdependencies

This unit provides the foundation for the rest of the module. Core definitions set out in the unit underpin discussion in subsequent units. Many of the concepts and issues raised in this unit, particularly with regard to climate change and its interactions with development, are expanded on, explained, and applied in subsequent units.

Do not worry if some of the climate change science, impacts and policy discussion in this unit are difficult to understand: most of these topics are covered more thoroughly in subsequent units. You may find it helpful to come back to this unit and its readings as you proceed through the module.

KEY READINGS

- ❖ Blunden J, Arndt DS, Baringer MO (eds) (2011) *State of the Climate in 2010: Highlights*. National Oceanic and Atmospheric Administration (NOAA) Report.

Available from: <http://www1.ncdc.noaa.gov/pub/data/cmb/bams-sotc/2010/bams-sotc-2010-brochure-lo-rez.pdf>

This short reading clearly outlines the nature of various climatic variables from 2010 and summarises climatic trends over the preceding 30 years. The reading contains some technical terms – do not worry about these at this point, you will become familiar with them as you work through Units 1–3 (and may wish to re-visit this summary when you have done so).

Note how the authors are very careful in their discussion of how specific year's data fit in with or conflicts with longer term trends, and the expectations from different climate models: the authors argue that much of this is due to the fluctuation between La Niña and El Niño conditions.

The reading links recent data findings to a summary of changes in GHG concentrations. You may wish to compare this summary with the evidence presented in the IPCC report:

- Where, and how, does the more recent evidence agree with, or conflict with, the IPCC data?
- Does this indicate whether climate change is happening in line with IPCC projections or towards either end of the predicted ranges?
- Can we learn anything about which parts of the evidence base are well founded, or less well founded and require further information?

Keep this report in mind as you work through the first three units.

The full reports are available online from:

<http://journals.ametsoc.org/doi/pdf/10.1175/1520-0477-92.6.S1>

You may wish to look back at particular chapters to see the detail behind the summary, particularly for areas contested or criticised by other authors.

- ❖ IPCC (2007) Summary for policymakers. In: Parry ML, Canziani OF, Palutikof JP, van der Linden PJ, Hanson CE (eds) *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, UK, pp. 7–22.

Available from: <http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-spm.pdf>

This is one of the main IPCC FAR summary reports. Note that some of the findings have been superseded by subsequent reports, but the IPCC reports continue to be the main sources of information for climate change policy discussions.

Read pages 8 to 18 in association with Section 1 of the unit to get an overview of projections of climate change impacts and of their interactions with development. As you read, note down the ways that climate change impacts may affect development.

Once you have read Section 3 you may like to check its characterisation of the scale, spatial issues, temporal issues, distributional tensions, complexity, and uncertainty of climate change processes against the description of climate change processes and impacts in this report.

Pages 19 and 20 are more relevant to Section 4 as they briefly introduce some of the issues around adaptation. Note the importance of both vulnerability and mitigation in the discussion of adaptation.

Do not worry if you cannot fully understand all the material in this reading or if you cannot grasp and remember the various impacts – you will come back to these in more detail in later units when you have a better understanding of climate change and of the terminology. Note the way that the IPCC reports its findings and the confidence/uncertainty around different projections (see page 21).

For a monthly update of the state of the global climate see: the '*State of the Climate Global Analysis*' published by the NOAA National Climatic Data Center which is

Available from: <http://www.ncdc.noaa.gov/sotc/global/>

FURTHER READINGS

Dessler A, Parson E (2010a) *The Science and Politics of Global Climate Change: A Guide to the Debate*, 2nd edn. Cambridge University Press, pp. 50–59.

Sections 2.4 and 2.5 of this reading discuss some aspects of the relationships between science and policy, outlining the value of science in informing policy, but also noting the limitations of scientific knowledge (the ‘what is’ happening), particularly when that knowledge contains uncertainty and may be contested, in contributing to policy (‘what should’ happen/be done) decisions.

These sections are also included in Unit 8, when we turn to more explicit consideration of policy processes, but are useful here in providing an overview as to the nature of climate change policy contexts.

Dessler A, Parson E (2010b) *The Science and Politics of Global Climate Change: A Guide to the Debate*, 2nd edn. Cambridge University Press, pp. 36–50 and 170–179.

The first reading here, Sections 2.2 and 2.3, provides an outline of the way science works and how it is used by policy-makers. It is useful for those less familiar with the methodology and conventions of science in illustrating the empirical process of hypothesis testing which, frequently, is better able to eliminate incorrect or incomplete theories than to demonstrate proof, and the ways in which this leaves room for different interpretations and use of scientific information.

The second reading builds on this, in discussing criticisms of the IPCC and the ways in which uncertainty in the science has been used by climate change sceptics.

Flavin C, Engelman R (2009) The perfect storm. In: *2009 State of the World: Confronting Climate Change*. Worldwatch Institute, Earthscan, London UK, pp. 9–11.

Available from: http://www.worldwatch.org/files/pdf/SOW09_chap1.pdf

This reading, written at the close of 2008, presents ten key challenges ‘to create the world of zero net greenhouse gas emissions that will be needed to achieve climate stability’.

From a different perspective now, with limited progress on global climate change policy since then, do you think each of these challenges is (i) necessary and (ii) achievable?

Looking across the ten key challenges and considering them together, what strikes you about the challenges they pose as a whole? How do they relate to the characterisation of climate change as a problem in Section 3 of the unit, and to the responses discussed in Section 4?

Global Humanitarian Forum (2009) *Human Impact Report: Climate Change – the Anatomy of a Silent Crisis*. Global Humanitarian Forum, Geneva.

Available from: <http://www.eird.org/publicaciones/humanimpactreport.pdf>

This report provides estimates of the human impacts of climate change – the numbers of people affected, deaths, impacts on critical resources and on the MDGs. There is also an extensive bibliography in the end notes.

Kirby A (2009) *Climate in Peril: a Popular Guide to the latest IPCC Reports*. United Nations Environment Programme (UNEP), Nairobi, Kenya.

Available from: <http://www.grida.no/publications/climate-in-peril/>

This provides an easy-to-read summary of core climate change processes. It goes some way beyond the material covered in this unit, but is highly relevant to the module as a whole. It also has a useful glossary and list of abbreviations and acronyms.

McKeown A, Gardner G (2009) Climate change reference guide. In: *2009 State of the World: Confronting Climate Change*. Worldwatch Institute, Earthscan, London, UK, pp. 189–204.

This provides helpful background information and a glossary of terms that will assist you in this unit and as you read subsequent units. Some of it provides more detail than you need now. If it is not covered in this unit do not worry, come back to it as you read other units. The link to an online version, which is updated from time to time, is given below.

Available from: <http://www.worldwatch.org/files/pdf/CCRG.pdf>

Richardson K, Steffen W, Schellnhuber HJ *et al* (2009) *Synthesis Report. International Scientific Congress: Climate Change: Global Risks, Challenges & Decisions*. 10–12 March 2009, University of Copenhagen.

Available from: <http://climatecongress.ku.dk/pdf/synthesisreport>

This synthesis report provides a key summary of the peer-reviewed scientific information available in early 2009. There is much detail here that may be difficult to absorb, Concentrate on the basic six key messages presented, and the broad evidence from which they are derived.

Different parts of this reading are relevant to different sections of the unit. Key messages 1 and 2 are particularly relevant to Section 1. Key messages 3 to 6 are particularly relevant to Section 4, which introduces responses to climate change.

In relating this reading to Section 3 of the unit, you may find it helpful to consider the following questions:

- Looking across the six key messages and considering them together, what strikes you about them as a whole?
- Note the peer review process involved in the presentation of this report (see preface on page 5). Why is such a process needed?
- Do you think each of these key messages is valid? From whose perspectives might it be valid/not valid? By what criteria might validity be judged?

Where do development questions come into in this scientific report on climate change?

Looking at the six key messages together, you might have noted similar points to those noted under the reading by Flavin and Engelman.

Scott L, Shepherd A (2011) *Climate Change as Part of the Post-2015 Development Agenda*. ODI Background Note, July 2011.

Available from: <http://www.odi.org.uk/resources/download/5765.pdf>

Knowledge of climate change and its potential impacts has developed significantly since the MDGs came into force (in 2000). As post-2015 (post-MDG) development policy discussions seek to learn from past successes and limitations, this background note outlines why climate change needs to be central to this process and in future policy formulation, discusses how this could challenge current development thinking and suggests ways in which climate change and development policies could be better aligned.

Sen A (2001) *Development as Freedom*. Oxford University Press, pp. 3–11.

Extract from a book by renowned economist and Nobel prize winner. Taking a human and social development perspective, Sen argues that development is about much more than economic growth. The importance of both political freedom and economic freedom are emphasised.

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Funtowicz SO, Ravetz JR (1992) Three types of risk assessment and the emergence of post-normal science. In: Krinsky S, Golding D (ed) *Social Theories of Risk*. Praeger, Westport, CT, pp. 251–274.

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Hare WL (2009) A safe landing for the climate. In: *2009 State of the World: Confronting Climate Change*. Worldwatch Institute, Earthscan, London, UK, pp. 13–29.

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Koplow D (2006) *Biofuels – At What Cost? Government Support for Ethanol and Biodiesel in the United States*. The Global Subsidies Initiative (GSI) of the International Institute for Sustainable Development (IISD), Geneva, Switzerland.

Available from: http://www.iisd.org/gsi/sites/default/files/brochure_-_us_report.pdf
[Accessed 5 March 2013]

McKeown A, Gardner G (2009) Climate change reference guide. In: *2009 State of the World: Confronting Climate Change*. Worldwatch Institute, Earthscan, London, UK, pp. 189–204.

Millennium Ecosystem Assessment (2005) *Ecosystems and Human Well-being: Synthesis*. Island Press, Washington DC.

Parry ML, Canziani OF, Palutikof JP and co-authors (2007) Technical summary. In: Parry ML, Canziani OF, Palutikof JP, van der Linden PJ, Hanson CE (eds) *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, UK, pp. 23–78.

PBU (undated) *Participatory Budgeting Unit*.

Available from: <http://www.participatorybudgeting.org.uk/> [Accessed 5 March 2013]

PLA (undated) *Participatory Learning and Action Series*. International Institute for Environment and Development (IIED).

Available from: <http://www.iied.org/participatory-learning-action> [Accessed 4 December 2013]

Ramalingam B, Jones H (2008) *Exploring the Science of Complexity: Ideas and Implications for Development and Humanitarian Efforts*, 2nd edn. Working Paper 285, Overseas Development Institute (ODI), London, UK.

RCPLA Network (undated) Resource Centers for Participatory Learning and Action.

Richardson K, Steffen W, Schellnhuber HJ *et al* (2009) *Synthesis report. International Scientific Congress: Climate Change: Global Risks, Challenges and Decisions*. 10–12 March 2009, University of Copenhagen.

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Sen A (2001) *Development as Freedom*. Oxford University Press, Oxford.

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UNEP (2003) *GEO Year Book 2003*. GEO: Global Environment Outlook, United Nations Environment Programme (UNEP).

Available from: <http://www.unep.org/GEO/yearbook/yb2003/089.htm>
[Accessed 5 March 2013]

UNEP/GRID-Arendal (2009) *Climate Change Global Processes and Effects*. UNEP/GRID-Arendal Maps and Graphics Library.

Available from: <http://maps.grida.no/go/graphic/climate-change-global-processes-and-effects1> [Accessed 5 March 2013]

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Urban F, Sumner A (2009) *After 2015: Pro-Poor Low Carbon Development*. IDS In Focus Policy Briefing 9.4, Institute of Development Studies (IDS), Brighton.

Available from: <http://www.ids.ac.uk/idspublication/after-2015-pro-poor-low-carbon-development> [Accessed 5 March 2013]

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MULTIMEDIA

An Inconvenient Truth: Trailer.

Available from: <http://www.youtube.com/watch?v=wnjx6KETmi4>

There are many videos and articles about climate change on the internet. Most of them have a particular message, and the selection and presentation of facts, arguments, possibilities etc is mixed and often serves the particular message being promoted. They vary in quality and they also vary in their use of up to date information.

The film *An Inconvenient Truth* by Al Gore has received much publicity, a Nobel Prize, and also much criticism. Watch the following trailer critically, asking what its purpose is and how it relates to 'complexity science' and 'wicked problem' perspectives of climate change.

Dorward AR (2009) *Integrating Contested Aspirations, Processes and Policy: Development as Hanging In, Stepping Up and Stepping Out.*

The audio and/or PowerPoint of presentation at the University of Reading, January 2009 can be found by following the links in the Interactive and Multimedia section in Unit 1 of your e-study guide.

StormCenter Communications and NOAA (2010) *State of the Climate in 2009*. Video.

This video accompanies the NOAA Report State of the Climate in 2009.

Available from: <http://www.climatewatch.noaa.gov/2010/videos/soc2009>

1.0 CLIMATE CHANGE AND DEVELOPMENT: THE CHALLENGES OF OUR TIME

Section Overview

Climate change and development are arguably the two most important challenges facing the world. This section outlines the context, nature, and scale of these two challenges and introduces some important parallels and interactions between them.

Section Learning Outcomes

By the end of this section, students should be able to:

- define the terms 'climate change' and 'development'
- discuss some of the interactions between climate change and development

1.1 Climate change challenges

What is 'climate change'?

The term 'climate change' refers to change in the longer term pattern of behaviour of the atmosphere over millennia or, more recently, as a result of natural processes or human activity. Climate is distinguished from weather, which is the specific behaviour of the climate at a particular time. Weather is made up of specific events, for example, a particular storm, the rainfall over a particular period, the temperature at a particular time. Climate is about expectations; weather is about events and conditions. 'Climate is what you expect, weather is what you get' is often quoted to describe the difference between climate and weather. Both weather and climate may refer to specific places or general areas, but whereas weather refers to actual time periods such as dates and times, climate refers to expected conditions in general time periods, for example, spring or summer, day or night, morning or evening. The most important variables that make up the climate are temperature, precipitation (rainfall, snow, hail), wind direction and speed, atmospheric pressure, humidity, the nature and extent of clouds, and hours and intensity of sunlight. There are, however, many possible ways by which climate may be described. These are generally associated with averages or variability in temperature, precipitation, wind and cloud. The climate varies spatially, for example, depending on the distance from the equator or the sea, and temporally, for example, depending on seasonal and daily variations.

For a discussion about the difference between global warming and climate change see 1.1.1, below.

1.1.1 Global warming or climate change?

The terms global warming and climate change sometimes appear to be used interchangeably. Strictly speaking, global warming is just one aspect of climate change, and is indeed an important driver of climate change. Apparently small increases in average global temperatures can lead to very large changes in other aspects of local and global climates. Changes in these other aspects of the climate – in averages in precipitation, winds, clouds, humidity, and in temporal and spatial variation and variability – may then have multiple impacts. Since global warming may also be accompanied by local or temporary falls in average temperature, the term climate change is a more accurate description of the problem the world faces.

Source: unit author

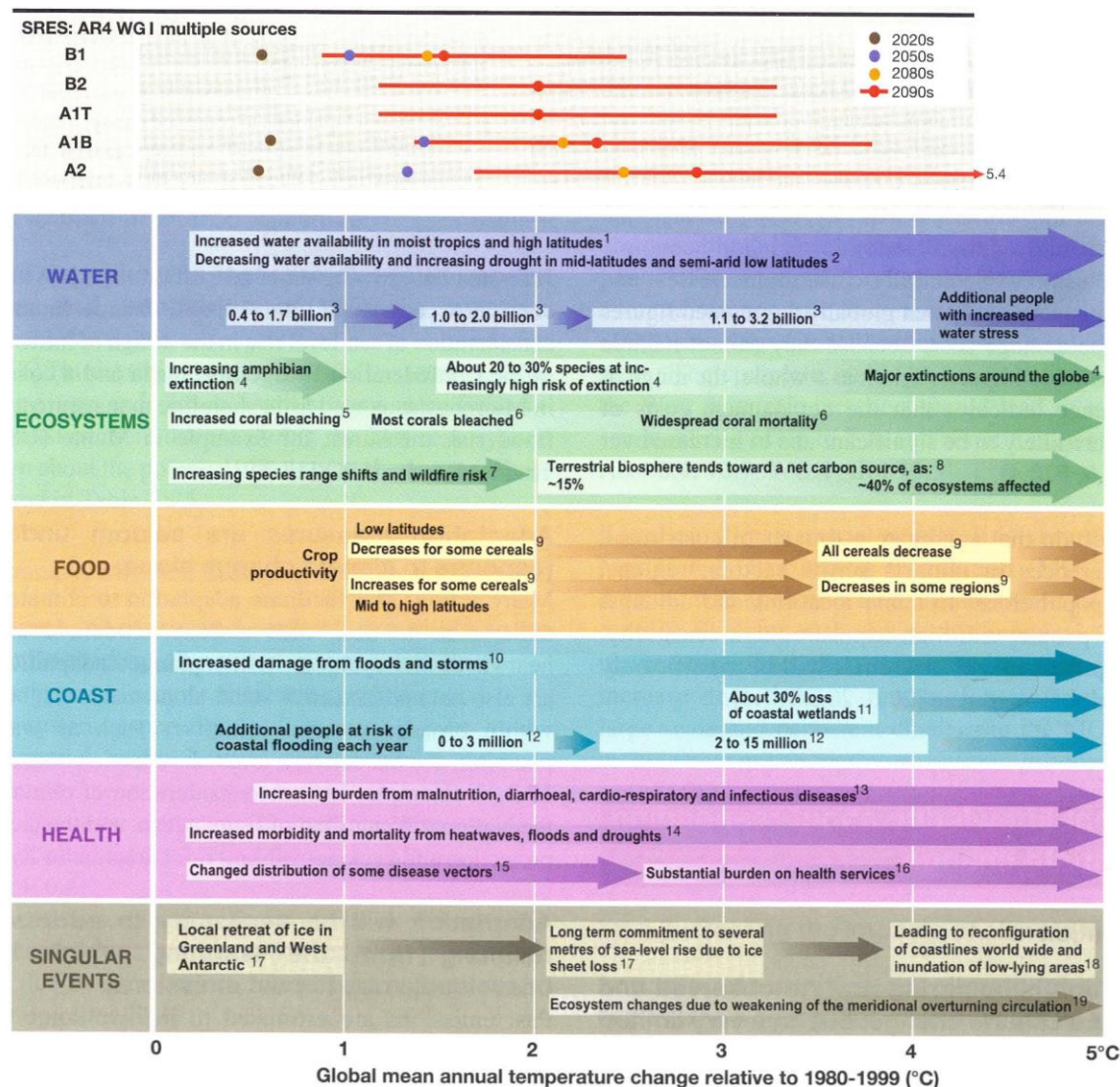
Whatever their causes and predictability, spatial and temporal variation pose challenges in measuring climate, as this variation is an important part of the climate. Thus climate can be described by averages of conditions at different times and places, by frequencies of certain events, by extreme events, and by the extent and nature of variability itself. Ultimately, the parameters and variables used to measure climate and climate change will be determined by understandings of what is important about climate – and this varies between people according to their livelihoods, locations, interests, and understandings of climate and its impacts on them.

Climate change impacts

It is now widely accepted that human burning of fossil fuels such as for energy, transport, and industry, forest clearance, and livestock-keeping are major contributors to the increases in average global temperatures. The figure in 1.1.2 provides more systematic information on the probable scale and scope of problems posed by global warming: apparently small increases in global average temperature can lead to very large impacts on terrestrial and aquatic ecosystems and on critical aspects of the lives and welfare of millions of people.

The figure in 1.1.2, taken from the IPCC Fourth Assessment Report, shows, in the top panel, the approximate time that particular global surface air temperature increases are predicted to happen under modelling of different scenarios defined by the IPCC against a 1980–1999 base. Thus, a rise of a little under 1 °C is expected to have occurred by 2020 under most models (an increase of over 0.3 °C above 1980–1999 had already occurred by 2008 (Richardson *et al* 2009)) and a rise of around 1.5 °C by 2050. For the 2090 predictions, under the A2 scenario, it is expected that temperature will have increased by about 3.3 °C above 1980–1999, but with a 67% probability that the temperature increase will be between 2 °C and 5.4 °C, whereas for the B1 scenario it is expected that, by 2090, temperature will have increased by about 1.8 °C above 1980–1999, but with a 67% probability that the temperature increase will be between 1.1 °C and 2.9 °C (see 1.1.3).

1.1.2 Probable impacts of climate changes associated with increases in global temperature



Source: Parry *et al* (2007) p. 66.

Note that superscripts refer to sources (see source document).

1.1.3 Global warming temperature increases

Discussion of global warming temperature increases can be confusing, as different reports may use different baselines from which increases are measured. The two most commonly used baselines are (a) pre-industrial conditions, with temperature measured from a 30-year average around 1850 and (b) the average over the period 1980 to 1999. The former is the base used in most policy discussions about setting limits on global warming. The latter is the base used in IPCC reports, and this is a little more than 0.5 °C above the pre-industrial base. 2 °C above the pre-industrial temperature is equivalent to

- approximately 1.5 °C above the 1980 to 1999 temperature, and
- approximately 1.2 °C above the 2007 average temperature (smoothed to allow for annual variations) since there was an approximate further 0.25 °C temperature increase from 1990 (the 1980–1999 midpoint) to 2007.

Source: unit author with information from Hare (2009) pp. 14–15.

The global temperature increases expected by certain dates (shown at the top of the figure in 1.1.2) can then be linked to the likely impacts of those temperature increases (shown in the main part of the figure in 1.1.2). Temperature increases of 1 °C above 1980–1999 lead to very significant impacts on water supplies and availability, on ecosystems, on food production, on coastal areas and those living there, and on health threats. There will also be 'singular events': structural and, in the medium term, irreversible changes in the behaviour of the ocean and climate system with major impacts on the climate.

These impacts will affect the basic needs of life – food, water, shelter, health – for billions of people and, often, it will be poorer people living in poorer countries who will be the most affected. This raises profound ethical and justice issues, since these people have generally made the least contribution to the causes of global climate change (the emission of greenhouse gases), and their lack of resources means that they are the least able to combat the impacts of climate change.

Unfortunately, there is increasing evidence that the IPCC FAR may underestimate both the climate impacts of global temperature increases, and the rate of global temperature increases. Richardson *et al* (2009 p. 8) report that 'Since 2007, reports comparing the IPCC projections of 1990 with observations show that some climate indicators are changing near the upper end of the range indicated by the projections or, as in the case of sea level rise, at even greater rates than indicated by IPCC projections.'

? Given the scale and severity of the impacts discussed above, are there other natural, social, and political impacts that might be expected to result from climate change? What do you think these might be?

Answer.

These are complex questions. We could examine each of the types of impacts set out in the figure in 1.1.2 and ask what secondary effect might these impacts have. Some of these will already be included – such as declining water availability impacts on irrigated food production, on sanitation and health. There are other potential secondary impacts not considered here – if water shortages, coastal flooding, and increasingly severe storms make some areas uninhabitable, will this lead to large-scale internal and international migration, and if so what will be the social and political impacts of this in different parts of the world? What will be the impacts of all these changes on 'terrorist groups' and security? A second set of questions arises around the responses to global climate change. If societies implement changes to try to reduce the extent of climate change or to protect themselves against climate change impacts, how will these measures affect different people?

We consider these questions again later in the unit.

1.2 Development challenges

What is development?

While 'climate change' is relatively easy to define, this is not the case with the term 'development'. As with many 'good' abstract concepts (such as equity, justice, and human rights), most people recognise the existence of development and would probably agree that its achievement is desirable and a good goal for societies to work towards. There is, however, considerable disagreement about just what development means.

We can think about development in terms of two major (and interrelated) dimensions. The first dimension makes a distinction between development goals and development processes. The second dimension distinguishes between the core concerns of development, identified here as economic and human development. This is illustrated in the table in 1.2.1.

1.2.1 Dimensions of development

	Processes	Goals
Economic development	Economic policies; infrastructural and market development; investment; economic and social structural changes; technical change; efficiency.	Improvements in material living standards; income, consumption, employment, savings and investment; food security; income and wealth distribution; poverty reduction, environmental protection.
Human or social development	Equitable economic growth; empowerment; governance; change in formal and informal rights and social and economic relations.	Capabilities; access to health and education services; rights; equity; freedom, empowerment; particular focus on minority and marginalised groups, on gender relations; security; dignity.

Source: unit author

As with many characterisations of development, the distinctions made in the table in 1.2.1 provide some useful insights, but development is too complex to fit into four neat and distinct boxes in a table!

First, the distinction between processes (or means of achieving development) and goals is not rigid. With regard to economic development, some of the goals are necessary parts of the process (investment, for example, is placed in both boxes). The interrelationships within economic development processes do not allow neat divisions into cause and effect, process and outcome. The difficulty in separating processes from goals is even greater with human or social development, since here the processes of people becoming conscious of, and working towards, their own and others' empowerment are themselves seen as a development goal and as an integral part of the development process. Sen (2001) describes 'development as freedom', and the internal and external development of capabilities are both goals and means of achieving freedom (to live, to participate in society, to choose, to consume, etc). Indeed, from a human development perspective, the separation of processes from goals may be seen as arising from a particular economic or technical and reductionist

view of development. Our understanding of development is often affected by our background – our cultures and personal histories as well as our professional education, training, and experience.

Second, the distinction between economic and human development is more blurred than may be suggested by the neat boxes in the table. There are, of course, important interactions between economic and human development with regard to both processes and outcomes. These are hinted at by the inclusion of 'equitable economic growth' as a human development process. This reflects the need for greater wealth to support investment in education, health, and other services. There are, however, questions about the extent to which different kinds of economic growth are inherently more or less efficient in driving increases in income, how those increases in income are distributed, and if they necessarily exclude (even destroy) more traditional or marginalised societies and livelihoods. Questions then arise about 'winners' and 'losers' from different kinds of development processes, and the contrasts between 'efficiency', 'needs', and 'rights' based development policy approaches (Derbyshire and Locke 2008).

The destruction of societies, cultures, and livelihoods by 'development' is often associated with globalisation and with inequities in power relations. Loss of access to or degradation of natural resources is another process that is often associated with 'development' (with the destruction of societies, cultures, and livelihoods which depend on those resources). Loss of access to natural resources occurs when traditional (generally poor) users do not have formal property rights or the means and power to protect their rights from other more powerful interests. Degradation of resources as a result of pollution or overuse can be analysed in a similar way: the fundamental problem is a lack of protected property rights. Of course, the degradation of resources does not just affect the poor and marginalised (although it affects them most). In the world we live in today (and especially in the context of climate change), it is not possible to discuss development without considering questions about sustainability and sustainable development.

Sustainable development

There are no clear and agreed definitions of sustainability and sustainable development. It is helpful to identify three dimensions of sustainability and hence of sustainable development.

- Environmental sustainability describes the ability of environmental resources to support an activity or set of activities.
- Economic sustainability describes the ability of an activity or set of activities to yield economic benefits greater than economic costs.
- Social sustainability describes the ability of social structures and/or behaviour to support an activity without being undermined by it.

? Pause for a moment and try to think of examples of different activities that are environmentally, economically, and socially unsustainable.

Answer.

Any system that involves the depletion of an individual's, an enterprise's or a society's environmental, physical, social or financial capital will not be sustainable. Examples include soil erosion, loss of soil nutrients, loss of biodiversity, the running down of investments, water or air degradation as a result of pollution if these changes undermine the physical and economic productivity of the system, the gains from the system for critical stakeholders, or social structures on which the system depends. A system that depends upon favourable conditions that are not expected to continue in the future will also not be persistent: for example, if it depends on low labour, energy or land costs in a situation where the prices for these inputs are expected to rise, or continued access to common resources (for example grazing or fishing) where these are being reduced by increasing pressure and exploitation. It is important to note here that there are important interactions between environmental, economic and social sustainability: failure in one of these dimensions is often caused by and/or leads to failures in one or both of the other two.

The Millennium Development Goals

Development, then, has many elements, and is difficult to define. It can be viewed in terms of goals and processes, in terms of economic and human development, and in terms of sustainability. There has, however, been an apparently remarkable agreement at the beginning of the 21st century around the idea that poverty is a core development problem, and that poverty reduction should be a common and unifying goal for development activities. This view of development can be characterised as a focus on **underdevelopment**. It applies particularly to 'international development' rather than to continuing and/or sustainable development in more developed economies. Our main focus in examining climate change and development is on the problems of underdevelopment in poorer countries, but we also consider a number of lessons and interactions between this and development processes and goals in more wealthy societies.

The growing focus on 'underdevelopment' in international development has been associated with international agreement at the United Nations in 2000 on the Millennium Development Goals (MDGs) as a unifying framework for international development activities. Currently, there are discussions ongoing for a post-2015 agenda after the MDGs. Climate-friendly development, such as low carbon development, plays a key role in the considerations for international development after the MDGs (Urban and Sumner 2009).

For an explanation of the Millennium Development Goals (MDGs) see 1.2.2, below.

1.2.2 Millennium goals

The Millennium Development Goals are an ambitious agenda for reducing poverty and improving lives that world leaders agreed on at the Millennium Summit in September 2000. For each goal one or more targets have been set, most for 2015, using 1990 as a benchmark:

1 Eradicate extreme poverty and hunger

Target 1: Reduce by half the proportion of people living on less than a dollar a day

Target 2: Reduce by half the proportion of people who suffer from hunger

2 Achieve universal primary education

Target 3: Ensure that all boys and girls complete a full course of primary schooling

3 Promote gender equality and empower women

Target 4: Eliminate gender disparity in primary and secondary education preferably by 2005, and at all levels by 2015

4 Reduce child mortality

Target 5: Reduce by two-thirds the mortality rate among children under five

5 Improve maternal health

Target 6: Reduce by three-quarters the maternal mortality ratio

6 Combat HIV/AIDS, malaria and other diseases

Target 7: Halt and begin to reverse the spread of HIV/AIDS

Target 8: Halt and begin to reverse the incidence of malaria and other major diseases

7 Ensure environmental sustainability

Target 9: Integrate the principles of sustainable development into country policies and programmes; reverse the loss of environmental resources

Target 10: Reduce by half the proportion of people without sustainable access to safe drinking water

Target 11: Achieve significant improvement in the lives of at least 100 million slum dwellers, by 2020

8 Develop a global partnership for development

Target 12: Develop further an open, rule-based, predictable, non-discriminatory trading and financial system. Includes a commitment to good governance, development, and poverty reduction – both nationally and internationally

Target 13: Address the special needs of the least developed countries. Includes tariff and quota free access for least developed countries' exports; enhanced programme of debt relief for HIPC countries and cancellation of official bilateral debt; and more generous ODA for countries committed to poverty reduction

Target 14: Address the special needs of landlocked countries and small island developing States

Target 15: Deal comprehensively with the debt problems of developing countries through national and international measures in order to make debt sustainable in the long term

Target 16: In co-operation with developing countries, develop and implement strategies for decent and productive work for youth

Target 17: In co-operation with pharmaceutical companies, provide access to affordable essential drugs in developing countries

Target 18: In co-operation with the private sector, make available the benefits of new technologies, especially information and communications

Source: UNDP

? Review the Millennium Development Goals and their targets and consider whether these are primarily concerned with development goals or processes, and with economic or human development.

Answer.

One might think that if the MDGs are goals then they must be primarily concerned with development goals rather than processes. This does tend to be the case, but goals 3, 7 and 8 are themselves actually more about processes. Looking at the targets under these 'process goals', some targets (4, 10 and 11) are more about goals, but others are more concerned with process development. However, these process development targets are poorly defined and 'woolly'. With regard to the balance between economic and human development, many of the goals and targets are concerned with human development. However, little is said about how these goals are to be reached, and there are important debates about how far expanded access to health and education services (which underpin MDGs 2 to 6) can be sustained without economic growth to finance them. There are also debates about what constitutes poverty, and therefore how far economic growth is needed to reduce and ultimately eliminate poverty. Target 1 in MDG1 is to reduce by half the proportion of people living on less than a dollar day, a very 'economic' definition of poverty.

Although there has been widespread agreement that reducing and ultimately eliminating poverty is a valid and unifying goal of development, there are almost as many understandings of poverty as there are of development. Low incomes are a common feature of poverty, but not all people with low incomes are poor (some people with large savings may have very low incomes, but are not poor). On the other hand, people with high incomes may be vulnerable to poverty if they have no alternative to those high incomes and have limited savings opportunities, and their high incomes are temporary, unstable, or carry large health or other personal costs. There are also other aspects of poverty identified by poor people themselves, for example, vulnerability, exclusion, marginalisation, powerlessness, discrimination, and these are often associated with chronic, intergenerational poverty and poverty traps.

Despite the difficulties there are in defining development, there is probably wide agreement that **development has made considerable progress** since 1990. For example, the fall in the percentage of people living on less than \$1.25 per day and the large increase in numbers of people living on \$1.25 or more per day, and the improvements in other indicators – noting that, with population increases, even a constant percentage achieving some improved development measure represents a large increase in the **number** of people achieving that measure. However **development has not made enough progress**, as is shown, for example, by the very large numbers and percentages of people who remain poor, undernourished, suffering from poor health services, discriminated against, and without improved water or access to modern energy. Note here that, with population increases, a constant percentage failing to achieve some improved development measure represents a large increase in the **number** of people failing on that measure. There are also major regional differences on many measures, differences which may be obscured by global data. On MDG1, for example, global falls in the proportion of people living on less than \$1.25 per day are largely the result of gains in China; gains in South Asia and sub-Saharan Africa have been much more limited. Nevertheless, today, most of the world's poor live in middle-income countries, such as in South Asia, Africa and Latin America. This situation is unacceptable: lack of development is still a pressing global problem.

1.3 Climate change and development interactions

There are two ways in which our separate examinations of climate change and of development suggest that the major global challenges of climate change and development interact: first, climate change impacts most heavily on poor and vulnerable people, and is therefore likely to set back development gains made in the past; and, secondly, climate change poses a threat to sustainable development.

 Look back at the figure in 1.1.2 which sets out IPCC FAR estimates of the likely impacts of climate changes associated with increases in global temperature. For each 'system' listed (water, ecosystems, food, coast, health, singular events) consider and write down the implications for MDGs 1 to 7. Also consider if there are other aspects of development (not included in the MDGs) which will be affected. Post your main conclusions on the online learning environment to share and discuss with other students.

Climate change threats to development progress

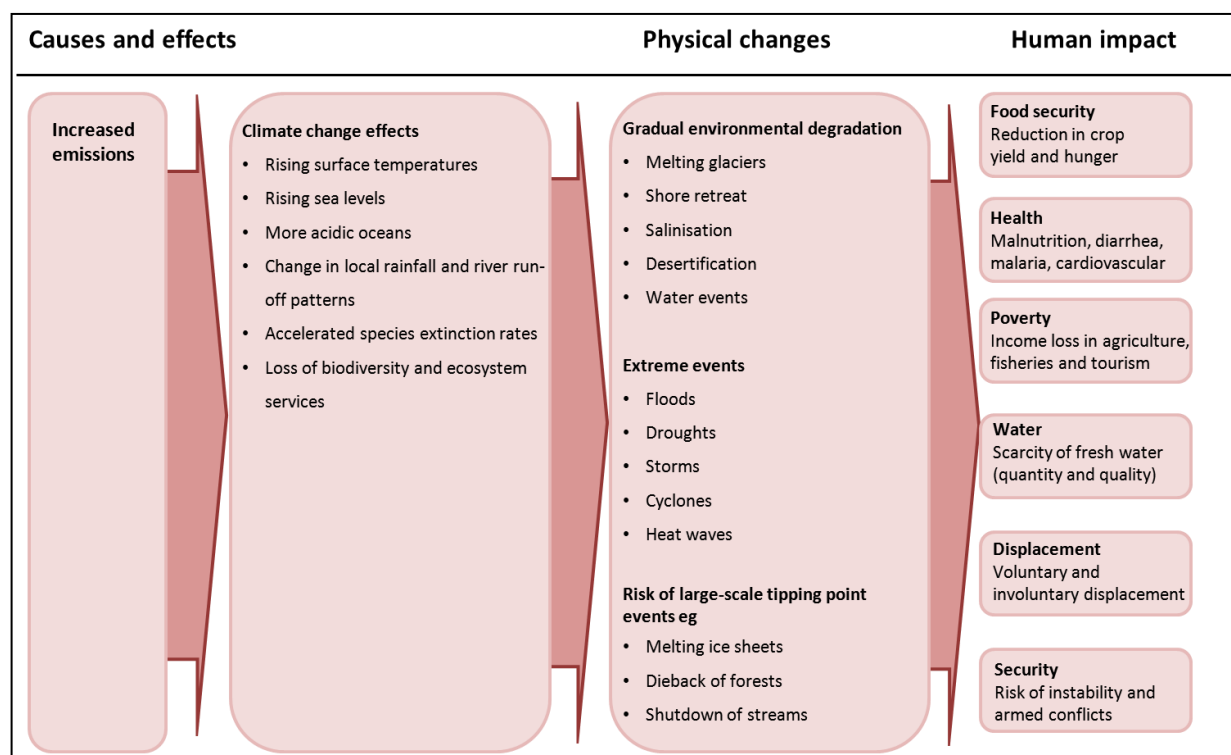
A major difficulty in the consideration of climate change impacts on development is the considerable uncertainty about the rate and nature of global warming, about the consequent rate and nature of its effects on different parts of the climate system, and then about the rate and nature of the effects of changes in these climate variables on human and economic development. Such uncertainty means that considerable care needs to be taken in interpreting estimates of climate change impacts on development. However, understanding of the physical, biological, and social sciences of climate change impacts is rapidly advancing. The previous estimates of climate change and its impacts have frequently been found to be more conservative than current estimates (see, for example, Richardson *et al* 2009), and this suggests that policy and planning should take account of more serious (rather than less serious) potential impacts.

For a discussion about the links between GHG emissions to human impacts see 1.3.1.

Indications of the ways that climate change is already undermining and negating existing development achievements is documented in the *Human Impact Report: Climate Change – The Anatomy of a Silent Crisis* (Global Humanitarian Forum 2009). This report recognises the uncertainty and difficulties inherent in quantifying climate change impacts on development and the risks of either over- or understating these impacts. However, it does attempt to draw together and triangulate across a wide range of information sources, including IPCC and other peer-reviewed and more conservative scientific reports and models, insurance industry information, international organisation reports, and case studies. The report estimates that, in 2008/2009, 325 million people were affected annually by climate change, with a further 315 thousand annual deaths due to climate change (these may be compared with annual global estimates of 24 million people needing medical attention after traffic accidents in 2004, 247 million cases of malaria in 2006, 22 thousand deaths from the Indian Ocean Tsunami in 2006, and 519 thousand deaths annually from breast cancer from 2004 to 2008) (Global Humanitarian Forum 2009 p. 11). These figures are calculated assuming that 40% of increased weather events and 4% of people affected and of deaths caused by environmental degradation are attributable to climate change (Global Humanitarian Forum 2009 pp. 9, 11). Global economic losses from climate change are estimated as US\$125 billion and are expected to more than double from 2010 to 2030 (Global Humanitarian Forum 2009 pp. 19, 20).

Critical human impacts of climate change arise through impacts on human habitat (for example, desertification, temperature increases, floods), on food security, health, poverty, water scarcity, displacement, and security (see the figure in 1.3.1, an animated version of which is available on your e-study guide).

1.3.1 The links from increased GHG emissions to human impacts



Source: Dalberg analysis, in Global Humanitarian Forum (2009) p. 23.

The figure in 1.3.2, below, outlines the impacts that climate change may have on the achievement of the MDGs.

1.3.2 Impacts that climate change may have on achievement of the MDGs

MDGs	Threat to MDGs
GOAL 1: Eradicate extreme hunger and poverty	• More frequent and intense weather-related disasters threaten livelihoods, regional food security is undermined, and vulnerability of poor people increases. • Water scarcity further aggravates the problem as vast amounts of fresh water are required to halve hunger. • Without the effects of climate change, about 10 million fewer people would live in poverty today. • The number of malnourished is expected to increase due to climate change.
GOAL 2: Achieve universal primary education	• Loss of livelihoods means more children will be engaged in income-earning activities and the displacement and migration of families will make education a low priority. • Infrastructure, such as schools, is destroyed. For example, in 1998, Hurricane Mitch destroyed one-quarter of all of Honduras' schools.
GOAL 3: Promote gender equality	• Women make up two-thirds of the world's poor and are more adversely impacted by disasters. • Additional burdens are placed on women's health as additional work and chores increase stress levels.
GOALS 4, 5 and 6: Reduce child mortality, improve maternal health and combat HIV/AIDS, malaria, and other diseases	• Women and children are particularly vulnerable to extreme weather events. For example, 90% of victims in the cyclone in Bangladesh in 1991 were women and children. • Children and pregnant women are particularly susceptible to vector- and water-borne diseases, malnutrition, and diarrhoea all of which are expected to grow due to climate change. About 90% of the deaths occur in children under 5.
GOAL 7: Ensure environmental sustainability	• Climate change causes fundamental alterations in ecosystems, such as losses of coral reefs, for example. • Climate change has reduced biodiversity. IPCC estimates that 20–30% of global species are likely to be at risk of extinction this century. • Climate change changes the quality and quantity of natural resources. For example, 20 million people in six countries in West and Central Africa rely on Lake Chad for water, but the lake has shrunk by 95% in the last 38 years.
GOAL 8: Develop a global partnership for development	• Investment in adaptation and mitigation is crucial and requires close co-operation and co-ordination. • The lack of adequate investment for adaptation acts as a significant drag on humanitarian assistance and development.

Source: Global Humanitarian Forum (2009) p. 68.

✍ Given the uncertainties about climate change and its impacts, and the very nature of climate change in increasing weather variability, it is immensely difficult to quantify historical, current, or future human impacts of climate change. *The Economist* (2009) comments that 'the trend looks plausible, but there seems little basis for the exact numbers' regarding the Global Humanitarian Forum estimate that 40% of increased weather-related disasters can be attributed to climate change. Most statements in the figure in 1.3.2 are either vague or illustrative. What is the value of information like this, and what are its dangers? You might like to post your comment on this on the online learning environment for discussion, and if you are interested you could also read more of the Global Humanitarian Forum report (2009) *Human Impact Report: Climate Change – The Anatomy of a Silent Crisis*.

It is difficult to determine with any degree of precision the current or future impacts of climate change on development. It is clear, however, that the scale of impacts is likely to be large, and that there will be many negative impacts to which poor people are and will be particularly vulnerable. Climate change is therefore likely to set back many of the development gains made in the past. Climate change makes development all the more urgent and important, if development can help build resilience to climate change impacts and the adaptive capacity for poor and vulnerable people. Similarly, the potential seriousness of climate change impacts on poor people, and its likely negative impact on development processes and goals, make tackling climate change all the more urgent.

Climate change threats to sustainable development

Climate change represents a fundamental threat to current patterns of development as it is clear that development which involves large-scale emissions of greenhouse gases is not sustainable: the climate system does not have the capacity to absorb large amounts of greenhouse gases without substantial changes in the climate, changes which undermine global natural and economic systems on which we currently depend. These include our water supplies, food systems, health, infrastructure, and settlements. Understanding these threats requires an understanding of the science of climate change, of the impacts of different human activities on climate change, and of the impacts of climate change on human activities and welfare. Major areas of human activity and welfare to consider here are agriculture, energy generation, transport, industry, settlement, water supplies, health, food supplies, lifestyles and vulnerabilities, and responses to disasters.

A consideration of the implications of climate science and the impacts for sustainable development needs to be set in the context of a broader understanding of the nature of climate change and development problems. We consider this in the next section.

Section 1 Self Assessment Questions

Question 1

Match the correct description.

- (a) climate change
- (b) weather
- (i) actual specific atmosphere behaviour or events such as storms, cold periods (days, nights)
- (ii) patterns of behaviour of the atmosphere, expected conditions

Question 2

Fill in the gaps in the following table using the words in the word bank below. Note that a word may correctly find a home in more than one place in the table.

Dimensions of Development

	_____	_____
_____ development	Economic policies; infrastructural and market development; investment; economic and social structural changes; _____; efficiency	improvements in material living standards; _____, consumption, employment, savings and investment; _____; income and wealth distribution; poverty reduction
_____ or social development	Equitable economic growth; _____; governance; change in formal and informal rights and social & economic relations;	_____; access to health and education services; rights; equity; _____, _____; particular focus on minority and marginalised groups, on gender relations; security; dignity

processes, goals, human, economic, freedom, empowerment, technical change, income, food security, capabilities

Question 3

List six properties required for a sustainable system.

Question 4

Reorder the MDG descriptions and climate change threats to match the MDG numbers in the first column.

MDG	MDG description	Climate change threat
1.	(i) Achieve universal primary education	(a) Children are particularly sensitive to combined stresses of increased exposure to malaria and water-borne diseases, shortages of clean water and malnourishment.
2.	(ii) Combat malaria, HIV and other infectious diseases	(b) Climate change poses major extra burdens on development resources and on official financial transfers from developed to developing countries.
3.	(iii) Develop a global partnership for development	(c) Insect-borne and water-borne diseases are often encouraged by higher temperatures and by flood events.
4.	(iv) Ensure environmental sustainability	(d) Global warming poses major threats to key terrestrial and aquatic ecosystems such as tropical forests and coral reefs.
5.	(v) Eradicate extreme poverty and hunger	(e) Loss of livelihoods will draw more children into income-earning activities.
6.	(vi) Improve maternal health	(f) More frequent and weather-related disasters threaten livelihoods; water scarcity in many areas undermines food production.
7.	(vii) Promote gender equality and empower women	(g) Pregnant women are particularly adversely affected by increased exposure to disease, work loads and migration.
8.	(viii) Reduce child mortality	(h) Women make up two-thirds of the world's poor people, and also carry particular burdens when livelihoods are stressed by ill health and by water and food shortages.

2.0 SHORT HISTORIES OF DEVELOPMENT AND CLIMATE CHANGE POLICIES

Section Overview

Climate change and underdevelopment are both global and national problems that are the focus of major research endeavours and of global and national policies, investments, and other interventions. In this section we briefly review the history of development and of climate change as recognised problems requiring understanding and action.

Section Learning Outcomes

By the end of this section, students should be able to:

- describe the broad history of national and international attempts to promote development
- describe the broad history of the threat of climate change as a global and national problem, and of national and international attempts to respond to this threat

2.1 A brief history of development policy

In its most general sense, development is a process that has gone on throughout human history as individuals and societies have attempted to better themselves. In Europe, concerted efforts to improve the conditions of disadvantaged sectors in society began in the 19th and early 20th centuries often spearheaded by religious or socialist groups. Such efforts were accompanied by the study of disadvantage, and eventually led, *inter alia*, to legislation and the establishment of government departments concerned with improving or protecting social welfare. However, the 'development' as a major government activity and field of endeavour extending beyond national borders emerged only after the Second World War, as a result of the need to rebuild the war-torn countries in Europe. European, US, and international organisations involved in reconstruction in Europe then turned their attention to the problems faced by countries in Africa, Asia, and Latin America as they began to gain their independence and as people and governments in former colonial countries recognised that they faced both obligations and opportunities in raising economic activities and living standards in their former colonies.

Development rapidly became mixed up with the Cold War, as international development assistance was seen as an extension of foreign policy, and the capitalist West (US, Canada, Europe, and Australasia) competed with the socialist East (Soviet Union, Eastern Europe, and China) to attract and keep Asian, African, and Latin American countries within their spheres of influence and trade. Understandings of 'development' changed, and became increasingly contested, with different theorists, northern and southern governments, international agencies and others, putting different emphases on political, social, economic, and technological change as the key constraints to and drivers of change. The collapse of the Soviet Union and the end of the Cold War led to, and coincided with, important changes in the practice and theory of international development, which has since largely been dominated by the west. There have, however, been continuing alternative currents, notably in some Latin American countries, such as Venezuela, Cuba, and Bolivia, in some non-governmental organisations (NGOs), and anti-globalisation and environmental movements in

the West, and most recently in the emergence of China as a major investor and economic player in Africa.

Theory and practice in international development are closely but not simply related. It is possible to identify different streams of development theory that have emerged over time. These have influenced and been influenced by development policies of governments in developed and developing countries, by international or multilateral development agencies (such as the World Bank and different UN agencies), and by NGOs. Interactions between theory and practice and among different organisations are complex and varied. Dominant practices of donor governments and international agencies are influenced by dominant theories, but they also support the development of dominant theories as they fund research and practice in line with dominant theory. However, failures of dominant practice throw up questions about the theories on which they are based, questions which are often explored and championed by NGOs, by alternative movements, and by alternative streams of academic research, writing, and teaching. Development theory and practice are also affected by the domestic interests of donor governments, and by wider economic and social ideologies in donor countries.

The main streams of development theory and practice that emerged in the 20th century are very briefly summarised in the table in 2.1.1.

2.1.1 Major streams of development theory and practice in the 20th century

Main stream	Origins	Characteristics
Modernisation	Experience of post war reconstruction in Europe, Stages of growth and Structural change theories.	Emphasises importance of investment and technical change, increasing industrialisation. Different capitalist and socialist models – 1950s, 1960s and 1970s.
Dependency	Failures of modernisation policies to generate growth and poverty reduction; Marxist and Neo-Marxist theories and their application in Latin America.	Emphasises unequal power relations between rich and poor economies and development as a perpetuation of such relations for the benefits of the powerful.
Neo-liberalism	Apparent failures of government-led modernisation investments; 1970s debt crisis and subsequent fiscal crises in developing countries. Reaganism and Thatcherism in the USA and UK.	Emphasises the importance of free markets (national and international); multiple weaknesses of governments. 1980s onwards

Source: unit author

Cutting across and within these streams were other approaches to development, which included the

- **basic needs approach**, which stressed the importance of investments to provide people with secure access to food, shelter, water, and education and health services, often through community-based organisation

- **environmental and natural resource management approaches**, which stressed the importance of natural resources in development and the threats posed by changing access to and productivity of natural resources
- **gender approaches**, which stressed the different situations and roles of women and men in societies and in development processes
- **the sustainable livelihoods approach**, which stressed the need for holistic and people-centred analysis and action
- **participatory and empowerment approaches**, with greater involvement of poor people in the definition and analysis of problems and priorities, and in action
- **micro-finance initiatives**
- **pro-poor growth and poverty reduction**

This list is by no means exhaustive.

Many of these approaches continue, and some are dominant parts of current development interventions. Other major themes and debates concern

- globalisation, its threats and opportunities
- public-private partnerships, with varied but more nuanced understandings of the complementary roles of governments, the private sector, and markets in development
- rights-based approaches, which emphasise legislation of people's rights to employment, food, and other basic needs
- the particular problems of poverty, human rights, and development in 'fragile states' (countries where the government is particularly weak) and countries in conflict

There are also continuing debates about, and changing emphases between, policies and investments for rural and for urban populations; for environmental threats; for agriculture, services and manufacturing as productive drivers of growth in different contexts; for welfare services (such as education and health); and for social protection (the provision of safety nets such as food aid, cash or food transfers, and pensions). These reflect growing dissatisfaction with more fundamental neo-liberal policies, as well as reactions to changing global and developing country situations – with the rapid economic growth and power of India, Brazil, South Africa, Russia and China (known together as the BRICS group of countries) the global commodity price spike of 2008; the subsequent financial crisis and recession; continuing global population growth and urbanisation; and increasing realisation of the severity and urgency of climate change threats. Many of these emerging problems draw attention to the importance of the political economy and processes of policy formulation and implementation and to co-ordination problems as a key development constraint.

2.2 A brief history of climate change policy

Awareness of climate change as an issue facing mankind, and action to address it, are relatively recent phenomena. The importance of the atmosphere in maintaining the temperature at the surface of the earth, the role in this of carbon dioxide's and methane's absorption of solar radiation, and the potential for global temperature increases as a result of industrial activities releasing carbon dioxide were first identified by Fourier, Tyndale, and Arrhenius in 1827, 1859, and 1896, respectively, in France, Britain, and Sweden. It was not until the late 1970s, however, that the World Meteorological Organization (WMO) began to

express concern that human activities – notably the emission of carbon dioxide – might lead to serious warming of the lower atmosphere. Scientific concerns about global warming grew during the 1980s, and in 1988 (a year when North America faced an intense heat wave and drought) these spilled over into political concerns, and the WMO and the United Nations Environment Programme (UNEP) established the International Panel on Climate Change (IPCC) to investigate and report on scientific evidence on climate change and possible international responses to climate change.

The IPCC has been central to the subsequent debates and processes around the development of climate change policies. Its first assessment report (in 1990) fed into the drafting of the United Nations Framework Convention on Climate Change (UNFCCC) in 1991. This was signed by 166 nations at the Earth Summit in Rio de Janeiro in 1992 and came into force in 1994. The UNFCCC did not contain any specific national or international targets to reduce greenhouse gas (GHG) emissions, but it contained key points or principles that have been foundational in subsequent international climate change debates and processes. It set out the following.

- An objective of stabilising the climate to prevent 'dangerous anthropogenic interference with the climate system' in a time-frame that would allow natural systems to adapt without major damage to food systems and economic development.
- The need for countries to monitor and limit their greenhouse gas emissions and for different national limits, taking account of countries' different responsibilities and capacities.
- Particular concerns for developing countries – and especially those most vulnerable to damaging climate change impacts, such as small island states.
- The importance of precautionary measures to respond to the severity of climate change threats, despite real scientific uncertainties regarding climate change processes and impacts.

In the absence of specific targets, the UNFCCC fell short of the aspirations of many environmentalists. However, it was an important step in establishing foundational principles to guide subsequent negotiations over national reductions in greenhouse gas emissions. These culminated in a Conference of Parties (COP) meeting in Kyoto, Japan, in 1997. This was the third Conference of Parties meeting (COP 3) where delegates agreed what is known as the Kyoto Protocol. This established developed country emissions targets for 2008–2012 and three main mechanisms for meeting them:

- an emissions trading scheme (ETS which allows international trade in emission allowances)
- Clean Development Mechanism (CDM), allowing developed country signatories emission credits for investing in emissions savings in developing countries. The only Kyoto mechanism that allows for investment in developing countries is the CDM.
- Joint Implementation (JI), allowing emission saving investments in other industrial (Annex 1) countries, including emerging economy countries, to be credited to signatory developed countries, promoting more cost-effective emission saving than could otherwise be achieved.

However, a number of countries (notably the US and Australia) subsequently refused to ratify the Kyoto agreement, arguing that developing countries also need to limit their emissions. These arguments were supported by major public debates questioning the scientific basis for climate change predictions – with substantial investments by the oil

industry, in particular, in lobbying groups questioning or denying climate change.

By 2007, 2008 and 2009 the existence and dangers of climate change were increasingly recognised with

- growing scientific evidence and understanding of climate change and its impacts, and increasing representation of this in the press (the publication of the IPCC fourth assessment report at the end of 2007 played a critical role in this)
- public awareness and concern about unusual weather patterns (for example, the extreme heat of the 2003 European summer; Hurricane Katrina and other storms around the world; floods, droughts, and fires in Europe, the US, and Australia)
- political change (notably in the US Administration, and in Australia)

National governments face major difficulties agreeing national contributions to international reductions in global emissions of greenhouse gases. On the one hand there is widespread recognition that drastic emissions reductions are needed. However,

- governments (and most importantly their electorates) do not want to bear the costs of such reductions in terms of increased energy costs, investments in new technologies and infrastructure, and lifestyle changes
- there are fears that countries with higher emission allowances will benefit from competitive advantages in international trade, while countries with lower emission allowances will suffer disadvantages and hence suffer economically
- rich (developed) countries with high emissions per capita face very large economic and social adjustment costs if they are to make substantial reductions in their emissions
- poor (developing) countries have lower current emissions per capita, but do not want either to be denied opportunities for economic growth and increased standards of living associated with increasing emissions, or to be forced down a more costly and slower development path constrained by keeping down greenhouse gas emissions
- poor (developing) countries need large financial and other resources to enable them to adapt to and cope with climate change impacts; in this they are looking to richer (developed) countries to provide a substantial part of these resources – as richer countries are better able to provide the necessary finance, and are primarily responsible for the greenhouse gases that have caused and continue to cause climate change

Differences in countries' perceptions are sharpened by the awareness in developing countries that developed countries have been and continue to be the major greenhouse emitters that caused the climate change problem, they currently benefit from and are trying to defend high levels of emissions per person, and are least vulnerable to climate change impacts. Developed countries, on the other hand, see per capita and total emissions rising fastest in rapidly growing, large developing countries – most notably China – and argue that this growth must be limited if global emissions are to be contained.

Despite the widespread agreement now reached about the seriousness of climate change, deep divisions therefore remain between countries with regard to the appropriate distribution of greenhouse gas emission limits and reductions. These are rooted in divergent national interests and perceptions, and strongly linked to issues of ethics, justice and development.

Complex technical and political challenges continue in

- developing principles to guide agreement on just and acceptable national emission targets
- agreeing such targets
- designing, agreeing, implementing, and monitoring mechanisms for achieving them
- key issues related to financing adaptation and mitigation in poor countries, access to climate-friendly technology for poor countries

These challenges posed major problems in the last COPs in Copenhagen in 2009, Cancún in 2010 and Durban in 2011, when negotiations were ongoing for establishing a legally-binding treaty for post-2012 after the first commitment period of the Kyoto Protocol. While Copenhagen was a major debacle, Cancún resulted in the Cancún Agreements which paved the way for a number of important arrangements, including the Green Climate Fund, the Technology Mechanism, the Cancún Adaptation Framework and Forest Management Reference Levels. After Cancún, many had hoped that Durban would deliver an agreement for the post-2012 phase. However, it was not possible to agree on key issues – such as binding emission reduction targets – and, disappointingly, the decision was taken that any global legally binding treaty for emission reductions would be negotiated by 2015 and come into effect by 2020. The Durban Platform for Enhanced Action was established to enable negotiations for a new global agreement for implementation in 2020. This delay of global action from 2012 to 2020 was criticised by NGOs, scientists and some governments as it delays global action to tackle climate change by almost a decade. The second commitment period of the Kyoto Protocol starts in 2013 and continues until 2017 or 2020 (depending on negotiations), but emission reductions are only required from developed countries that signed up to it, thereby excluding major emitters such as the US, Russia and Japan and emerging emitters such as China and India. A new global agreement, starting in 2020, is therefore crucial to tackle global climate change.

Section 2 Self Assessment Questions

Question 5

Fill in the missing words/phrases from the pool below.

basic needs

climate change threats

co-ordination

dissatisfaction with neo-liberalism

globalisation

neo-liberalism

population growth and urbanisation

roles of agriculture, services, and manufacturing

social protection

sustainable livelihoods

Changing development practice and concerns from the mid-20th century

Main streams of development theory and policy in the 20th century	Modernisation, Dependency, _____
Other approaches to development in the 20th century	_____, environmental and natural resource management, gender, _____, participation and empowerment, micro-finance, pro-poor growth and poverty reduction
Other major themes and debates	_____, public private partnerships, rights-based approaches, _____, fragile states and countries in conflict
Current/emerging issues/debates	rural vs urban investments, _____; importance of welfare services, _____, political economy and processes of policy formulation and implementation, _____
Changing conditions/opportunities/threats/lessons	rapid growth of BRICS, 2008 global commodity price spike, 2009 financial crisis and recession, _____, _____

Question 6

Arrange the following in date order, matching the dates.

- Agreement on the UNFCCC at the Rio de Janeiro Earth Summit
- Concerns about warming of the atmosphere
- COP 15 meeting to agree emissions targets after the expiry of the Kyoto Protocol agreements
- Discovery of the importance of the atmosphere in maintaining the temperature at the surface of the earth
- Discovery of the potential for global temperature increases as a result of industrial activities releasing carbon dioxide
- Discovery of the role of carbon dioxide and methane in absorbing solar radiation
- Effective start of the Kyoto Protocol emissions targets
- Year in which new global climate agreement is supposed to start
- Expiry of the Kyoto Protocol emissions targets agreements – first commitment period
- Publication of the IPCC Fourth Assessment Report
- Third Conference of Parties meeting (COP 3) agreement on the Kyoto Protocol
- WMO and the United Nations Environment Programme established the International Panel on Climate Change

Date	Event
1827	
1859	
1896	
Late 1970s	
1988	
1992	
1997	
2007	
2008	
2009	
2012	
2020	

Question 7

List four key points or principles in the UNFCCC that have been foundational in subsequent international climate change debates and processes.

3.0 CONCEPTUALISING CLIMATE CHANGE AND DEVELOPMENT PROBLEMS

Section Overview

This section considers ways of conceptualising climate change and development processes in order to identify inherent features that pose particular policy analysis, formulation and implementation difficulties. We then consider possible alternative analytical and policy approaches that may be used in climate change and development policy analysis, formulation, and implementation.

Section Learning Outcomes

By the end of this section, students should be able to:

- outline particular conceptualisations of climate change and development processes for understanding and integrating key features of these processes
- explain why the problems posed by climate change and development are particularly difficult to address, and how to address these problems

3.1 Conceptualising climate change and development problems

Features of the climate change problem

Climate change poses problems in terms of what needs to be achieved, how, by whom, when, with what resources, and from whom. The conventional 'modern' or scientific problem-solving approach seeks first to define and understand a problem in order to identify and develop possible solutions. Climate change may be seen as a particular example of an environmental problem, one that is particularly serious in both its scale and its features.

The figure in 3.1.1 is a representation of the processes by which environmental problems arise. Stocks of non-renewable resources are exploited to provide energy, food, and other commodities for consumption, and the process of exploitation also produces waste (this may also lead to direct damage of renewable resources, but this is not shown in the diagram). Renewable resources provide a set of ecosystems services (Millennium Ecosystem Assessment 2005) that may be categorised in terms of

- **support** to natural and artificial processes (for example, soil formation, the recycling of nutrients)
- **provisioning** or **production** of goods and services (for example, food, water, timber, fibres)
- **regulation** of natural systems (for example, of the atmosphere temperature, composition and behaviour; of ocean acidity; of water quality and availability; of pests and disease pathogens)
- **culture** (for example, spiritual and religious experience, recreation)

Goods and services from non-renewable and renewable resources are used for intermediate production and/or for consumption, which is driven by and drives non-renewable and renewable resource use, and is driven by and drives population growth and economic

The figure in 3.1.1 is relevant to climate change as climate change is fundamentally an environmental waste management problem. Greenhouse gases are wastes produced in the process of

- extracting non-renewable resources (for example, in the release of methane and the burning off of natural gas when extracting fossil fuels and in the extraction of oil from tar sands)
- extracting renewable resources (for example, through burning and the decomposition of soil and other organic matter when timber is extracted and forests are destroyed)
- food (crop and particularly livestock) production
- intermediate production and consumption involving, for example, energy use (burning of fossil fuels) and building (cement production)

The climate change problem is, however, a particularly pernicious environmental problem for the following interrelated reasons.

- **Scale:** Climate change is a global problem. Greenhouse gases are being produced in massive quantities all over the world – approximately 7.8 Gt of carbon, that is 7.8 billion tonnes, was emitted from the burning of fossil fuels in 2005 (Houghton 2009 p. 40) – the costs of reducing greenhouse gas emissions are very large, but the costs of climate change impacts from not reducing green greenhouse gas emissions are even larger (Stern 2007). Processes and events at a global scale are affected by and also drive processes and events at smaller scales (for example, regional, locality, and ecosystem).
- **Spatial issues:** There are a number of problematic spatial features of climate change.
 - First, greenhouse gas emission is highly diffuse and dispersed – it involves literally billions of individuals and firms in every country and continent on the planet, and each polluter makes only a very small contribution to global greenhouse gas pollution. This makes greenhouse gas emissions very difficult to control (contrast this with 'point pollution' where pollution emerges from one fixed, well-defined, and easily identified and controllable source, like a factory polluting a river).
 - Second, the environmental costs of greenhouse gas emissions are also highly dispersed, all over the world, as they are borne by billions of people in every country and continent on the planet.
 - Third, incurring these costs is completely disconnected from the responsibility for emitting greenhouse gases, and there are no simple institutional (political, social, and economic) or technological ways of linking them. Furthermore, as we have seen, those individuals and countries that are responsible for the greatest greenhouse gas pollution are generally less affected by the negative impacts of climate change than people and countries producing less greenhouse gases.

These three spatial features lead to an extreme case of what economists term '**externalities**', where (as a negative externality) the full costs of polluting the atmosphere with greenhouse gases are not borne by the person or firm or country responsible for the pollution, and hence there is no incentive to limit that pollution.

- **Temporal issues:** Greenhouse gas emissions lead to the slow development of diverse harmful climate change impacts which are more or less permanent. This occurs as a result of the long-term stability of major greenhouse gases in the atmosphere, the

slow rate at which CO₂ is absorbed from the atmosphere by the ocean, the slow rate of heating (and cooling) of the ocean, and the existence of **tipping points**.

A **tipping point** occurs where climate changes lead to a qualitative or structural change in the climate system which prevents (or at least hinders) movement back to the previous equilibrium. An example of a possible tipping point is the loss of sea ice or snow cover leading to reduced reflection and increased absorption of solar radiation. If this then promotes global warming to the extent that this leads to further snow or ice melt, then a tipping point has been reached.

The slow but permanent onset of some climate change impacts has two important implications for climate change as a pernicious environmental problem. First, it means that there is considerable disconnect in most people's thinking and experience between current greenhouse gas emissions and their future impacts (a disconnect that is exacerbated by uncertainty about climate change impacts, as discussed below). Second, it means that many climate change impacts from current greenhouse gas emissions will not be experienced by people alive now and responsible for those emissions, but by future, as yet unborn generations. This adds another dimension of difficulty to the externality problem discussed above.

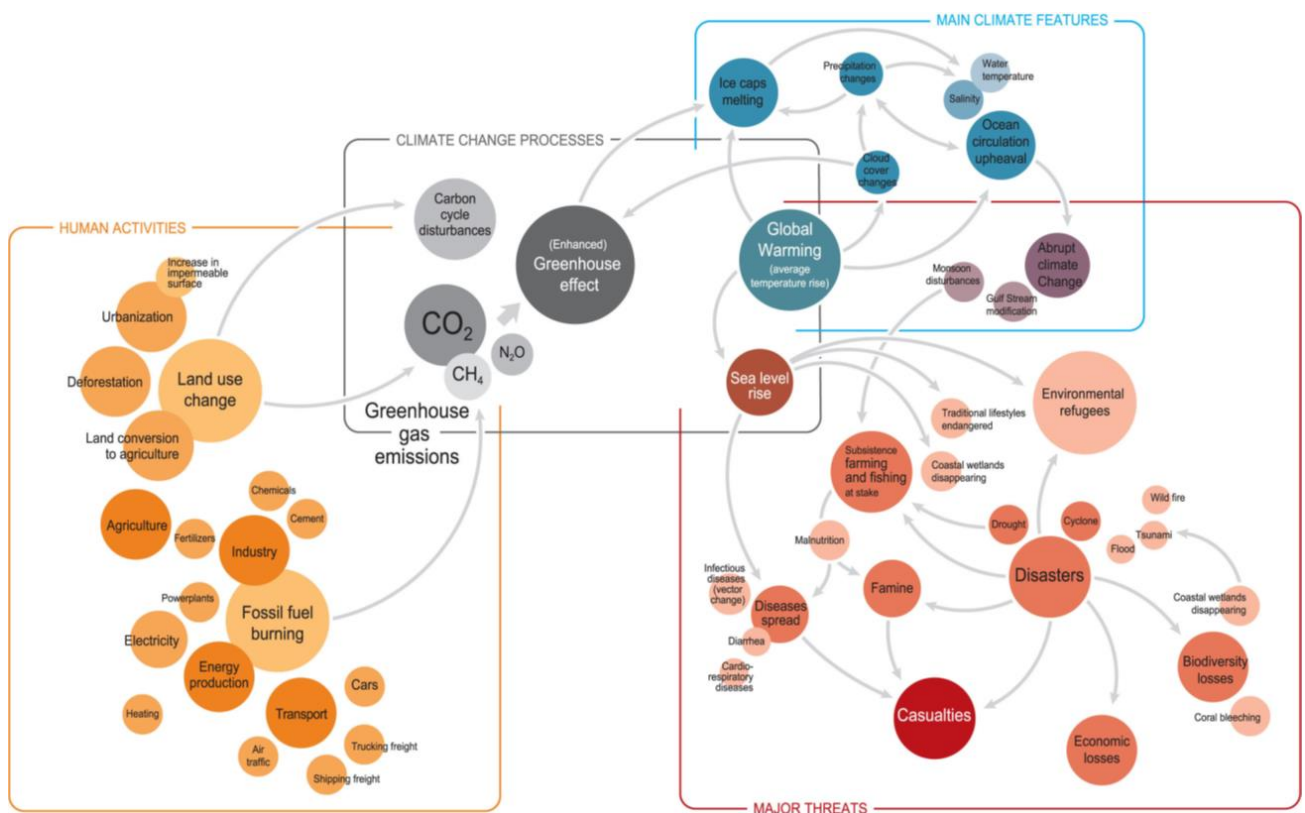
- **Distributional tensions:** As noted earlier, both the costs of climate change impacts and the benefits from activities producing greenhouse gas emissions (together with the costs of reducing them) are unevenly distributed. They are also, to a significant extent, inversely distributed. There are therefore widely divergent interests in and incentives for controlling greenhouse gas emissions by different amounts and in different ways. This is complicated by
 - many people and countries with the greatest interest in reducing greenhouse gases having the least resources and power to reduce greenhouse emission or to promote emission reductions
 - those individuals and countries currently producing the lowest emissions having an interest in reserving the right to increase their emissions in the future to allow economic development
 - there being both spatial and temporal aspects (as discussed above) in these distributional issues
 - complex arguments regarding what are just and/or politically (and technologically) practical or achievable solutions in different time-frames
- **Complexity:** Climate change is hugely complex. It involves economic, social, physical, biological, and chemical processes which are, in themselves, highly complex, but which also interact in complex ways, and at different scales across different parts of the world. These processes and interactions involve multiple variables, and many non-linear relationships. This means that many different people from different disciplines and countries need to work together, but such interdisciplinary and international work is challenging not only intellectually but also in the way that experts from different professional disciplines and different cultures approach or frame problems and communicate and work with each other. The complexity of the climate change also makes it very difficult for 'climate change experts' to communicate findings with politicians and with 'ordinary people' – both about the climate change experts' analysis and about the concerns of politicians and 'ordinary people' – the people who really matter.

- **Uncertainties:** Uncertainty arises from
 - the complexity of climate systems and their interactions with other systems (economic, social, industrial, political, etc)
 - limited understanding of the very complex science of global warming and climate change
 - uncertainty about how human activity will change in future (in response to a wide range of different factors, including climate change) and about how this will affect climate change and vulnerability to climate change
 - significant spatial variability in climate change and its impacts, between different parts of the world

Uncertainty is related to and exacerbates difficulties in communication and in addressing distributional tensions, and the temporal and spatial issues and externalities discussed above.

Some of these features are represented in the figure in 3.1.2.

3.1.2 Climate change global processes and effects



Source: UNEP/GRID-Arendal (2009)

The figure in 3.1.2 shows the multiple, diverse, and diffuse sources of greenhouse gas emissions feeding into climate change processes. These then impact on the main (and interacting) features of the climate (ice caps, precipitation, ocean circulation, cloud cover, and of course air and ocean temperatures), and these then cause extensive, diverse, diffused, and variable threats (for example, to farming and fishing, coastal ecosystems, disease incidence and effects, food security, biodiversity, multiple ecosystem services, and local and national economies).

This figure illustrates well the scale of climate change problems, spatial characteristics, potential distributional tensions, and complexity. It does not directly show problems associated with the temporal features of climate change and uncertainty, but these can be readily inferred from the nature and complexity of the climate processes and changes.

Conceptualising development

Development processes and underdevelopment problems share many of the same characteristics as climate change processes and problems.

 Take a moment to look back over the features of climate change that lead to it posing a particularly pernicious environmental problem, and consider how many of these apply to problems of underdevelopment (although obviously this is not normally an environmental problem).

Globally, the scale of underdevelopment problems is very large, and larger scale (macro) processes interact with smaller scale (micro) processes. There are significant though different **spatial issues** (with regard to relations between developed and developing countries, communications and service delivery costs and difficulties in rural areas and remote regions, and interactions between global changes and individuals' livelihoods). **Temporal issues** are also significant, with regard to the dynamics of development processes and changes; problems posed by seasonal cycles and uncertainty in, for example, agriculture, health, and food security; and the existence of 'tipping points' (normally described in terms of poverty traps in development contexts). **Distributional tensions** are a major concern in underdevelopment and underpin debates about the importance of equity in growth; about the extent and significance of changing patterns of inter- and intra-national equity and inequity in incomes and wealth; about power relations; about winners and losers in development; and about relative and absolute poverty. Distributional and **power tensions** are also related to development concerns about marginal and vulnerable groups, gender relations, and rights-based development approaches.

Development is also highly complex, involving multiple social, technical, and economic processes interacting at different scales; multiple stakeholders; and dynamic natural and social processes in the development and exploitation of different forms of capital – including natural or environmental capital.

There are also numerous **externalities** in development processes. These take a different form from externalities in climate change. They tend to be positive rather than negative externalities, as there are wider gains to society than to individuals when individuals decide to engage in an activity, although negative externalities still

occur – and indeed development can be associated with negative externalities from pollution. Examples of positive externalities inherent in many development processes are **spillover effects** where if one or more individuals or firms engage in an activity then this leads to the local development of capital (for example, human capital in skills, social capital in institutions, physical capital in infrastructure) which other firms engaging in the activity can benefit from. Such externalities can be important causes of poverty traps as they lead to higher costs for initiating and operating new activities in an underdeveloped area compared with investing in such activities in more developed areas. Overcoming such poverty traps may require government interventions, either to co-ordinate investment by a number of private enterprises or to subsidise initial investments in an underdeveloped area.

Constraints imposed by climate change may involve shocks affecting natural, human, social, and physical capital, affecting the balance between hanging in, stepping up, and stepping out activities, and the frequency and severity of falling down and out. Sustainable development may require greater emphasis on hanging in, limits on the scale and nature of stepping up and stepping out, and a different balance between holding of and investment in different types of capital, and different emphasis on the services they provide.

3.2 Climate change and development as ‘wicked’, complex problems

Climate change and development as complex systems

The features of climate change and development processes and problems as described in Section 3.1 do not fit neatly into conventional scientific characterisations of problems. This may seem obvious, as the scope of climate change and development problems clearly extend beyond the individual natural and social sciences. Even so, is it possible to apply a conventional ‘modern’ or scientific approach by first defining and understanding a problem in order to identify and develop possible solutions? Growing experience with attempts (and failures) to solve complex, multi-disciplinary, multi-stakeholder problems suggests that the conventional ‘modern’ or scientific approach does not work in such situations. To explore how such problems can be addressed, it is helpful to consider alternative ways of viewing problems. Thinking around ‘complexity science’ is outlined in 3.2.1.

3.2.1 Complexity science

Increasing appreciation of the difficulties, indeed failures, of scientists in finding solutions to complex problems has led to a search for alternative approaches to formulating problem and problem solving.

Complexity science encompasses a range of ways of looking at the dynamic unpredictable behaviour of connected systems, networks and problems, whether these are purely physical or stretch across social and natural systems. Nine key characteristics of complexity systems can be identified (Ramalingam and Jones 2008):

- (1) Interconnected and interdependent elements and dimensions.
- (2) Feedback processes that shape how change happens.

- (3) The behaviour of systems emerge – often unpredictably – from the interaction of the parts, such that the whole is different from the sum of the parts (a characteristic known as ‘emergence’).
- (4) Within complex systems, relationships are frequently nonlinear, ie when change happens, it is frequently disproportionate and unpredictable.
- (5) Sensitivity to initial conditions means that small differences in the initial state of a system can lead to massive differences later.
- (6) Order underlying the seemingly random behaviours of some complex systems can be explained in terms of movements across boundaries of dominance of different structural equilibria (known as ‘strange attractors’).
- (7) Adaptive agents (living organisms) react to the system and to each other.
- (8) Self-organisation characterises a particular form of emergent property that can occur in systems of adaptive agents.
- (9) Co-evolution describes how, within a system of adaptive agents, co-evolution occurs, such that the overall system and the agents within it evolve together, or co-evolve, over time.

Source: compiled by unit author based on Ramalingam and Jones (2008)

Climate systems, broadly defined to include factors affected by greenhouse gas emissions, show all the characteristics of complex systems. Development processes also have these characteristics. This is particularly the case when we consider their interactions.

What problems do complex systems pose for problem solving? A helpful perspective on this question is provided by thinking about ‘wicked’ problems.

Climate change and development as ‘wicked’ problems

The principal characteristics of ‘wicked’ problems are summarised in 3.2.2.

3.2.2 Wicked problems

‘Wicked problems’ are problems that have a particular set of characteristics that make them difficult to address – but are common and important in modern societies. Wicked problems are not bad in a moral sense, but pose intractable difficulties to conventional scientific problem-solving approaches. They have the following principal characteristics (Rittel and Webber 1973; Australian Public Service Commission 2007):

- (1) Wicked problems are difficult to define clearly; have many interdependencies and often have multiple causes, and these can be defined at different levels in hierarchies of causes.
- (2) There is no definitive formulation of a wicked problem, as the information needed to understand the problem depends upon initial ideas for solving it (and thus depends upon the backgrounds, training and experience of those looking for solutions).
- (3) There is no test of a solution – any solution, when implemented, will generate intended and unintended consequences over an extended period of time, and hence change the problem.
- (4) Similarly, solutions are not true-or-false, correct-or-incorrect, but good-or-bad, and thus their evaluation and acceptance depends upon judgments that are likely to differ widely between individuals and groups with different interests, values, and backgrounds.
- (5) Every solution is unique, as every problem is unique, but there is also no opportunity to learn by trial-and-error as attempts at solutions themselves change the problem.
- (6) Solutions are socially and organisationally complex, and require co-ordinated action by a range of stakeholders, including government agencies at national and subsidiary levels, non-profit organisations, private businesses, civil society groups, and individuals, and do not fit neatly within the responsibility of any one agency.

- (7) Solutions tend to involve changing behaviour.
- (8) Some wicked problems are characterised by chronic policy failure.
- (9) There is no definitive solution or resolution to the problem, at the end of which the problem is solved – rather the problem and measures to address it continually evolve.

Source: compiled by unit author drawing on Rittel and Webber (1973); and the Australian Public Service Commission (2007)

Again, climate change and development pose problems that have many of the features of 'wicked' problems. This is particularly the case when we consider their interactions.

? Which features of 'wicked' problems are encountered in attempts to decide what needs to be achieved in tackling climate change, how, by whom, when, with what resources, and from whom?

Answer.

The boundaries and elements of climate change as a problem interact and are difficult to define (potentially extending from individual lifestyles to international government agreements; from primary school education to climate change modelling). This means that there is no definitive formulation of the problem. As the climate and knowledge and perceptions change, so the problem changes. Local sub-problems differ from place to place. Stakeholders from developed and developing countries, from different industries and interest groups, have different perspectives and goals. Co-ordination and behavioural change are critical, and unintended consequences are likely. Climate change policies have not generally been marked by dramatic success!

3.3 Addressing complex, 'wicked' problems

How then can the 'wicked' problems posed by complex systems be addressed?

Roberts (2000) suggests three alternative strategies for dealing with 'wicked' problems:

- **authoritative strategies** – where an authority decides and imposes a solution
- **competitive strategies** – where different stakeholders compete to deliver a solution
- **collaborative strategies** – where different stakeholders work together to develop and implement solutions

Whereas authoritative strategies may appear to deliver efficient and timely solutions, these solutions commonly do not take sufficient account of the interests and perspectives of critical stakeholders needed to make them work, and they consequently break down and indeed aggravate the problem by alienating key stakeholders. Competitive strategies involve competition for power and/or resources, and can generate ideas, resources, and choice. However, they can also waste resources, and lead to alienation and the marginalisation of key interests.

Collaborative strategies generally have the most potential to generate the continual, multifaceted, and multi-stakeholder processes needed to address 'wicked' problems. However, they often involve high transaction costs in engaging with stakeholders. If poorly managed and facilitated they can also break down and alienate stakeholders.

Funtowicz and Ravetz (1992) propose an approach that they call 'post-normal science' to deal with problems that share many of the features associated with 'wicked' problems but which they characterise in terms of conflicting interests around high decision stakes, with high uncertainty with regard to systems and processes. Saloranta (2001) describes post-normal science as a diverse set of approaches to problem solving with a common emphasis on an 'extended peer community' which brings together different stakeholders with various perspectives on the issue into the dialogue assessing science inputs into decision-making. He argues that more efficient decision-making should emerge from enhanced diversity and mutual understanding and trust in the Extended Peer Community. 'Post-normal science' can also manage uncertainty better than normal science, both through the process of extended peer community engagement and through better communication of methodological, epistemological, and ethical uncertainty alongside technical uncertainty (which is routinely communicated using statistical measures).

Saloranta (2001) goes on to analyse the work of the IPCC in terms of the application of post-normal science to the climate change problem. He argues, for example, that its work has involved an extended peer community of climate and social scientists in the three working groups, and that its presentation of uncertainty takes account of methodological and epistemological (if not ethical) uncertainty.

 Examine the way that IPCC (2007) handles uncertainty by, for example, looking at the 'Summary for Policymakers' (IPCC 2007 pp. 8, 9 and Box 2 on p. 21).

What aspects of uncertainty are allowed for in the presentation of projections and findings? Do you think that this is an appropriate, clear, accurate, and effective way of communicating about the uncertainty in these projections and findings?

There is an increasing emphasis in development on the involvement of people in development processes, with widespread use of participatory processes and methods – for example

- 'participatory budgeting systems' (PBS) – google 'participatory budgeting' or look at the Participatory Budgeting Unit weblink (PBU undated), or UN-Habitat (2004)
- 'participatory learning and action' (see PLA undated, RCPLA undated)
- 'participatory poverty assessment' (PPA) (FAO undated)

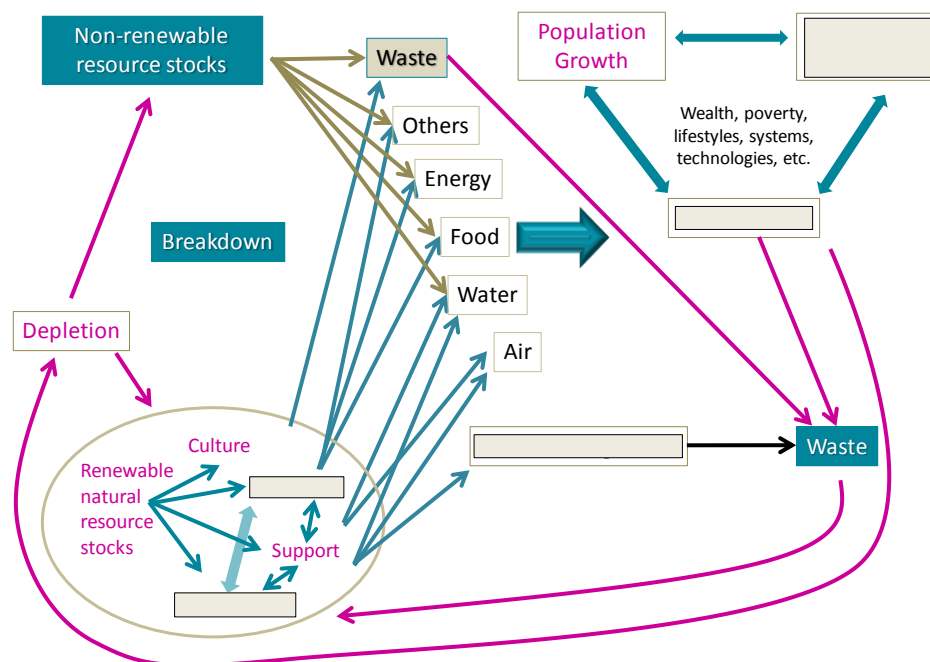
Are these examples of the application of post-normal science in development? You may like to post some ideas for debate on the online learning environment.

Section 3 Self Assessment Questions

Question 8

Fill in the following missing words/phrases in the diagram below.

Production waste management regulation
Depletion consumption economic growth



Question 9

Match the type of science to its description.

Post-normal science

Complexity science

- encompasses a range of ways of looking at dynamic unpredictable behaviour of connected systems, networks, and problems
- encompasses a range of approaches to problem solving with a common emphasis on an 'extended peer community' which brings together different stakeholders with various perspectives on the issue into the dialogue assessing science inputs into decision-making

Question 10

List three alternative strategies for dealing with 'wicked' problems.

4.0 RESPONDING TO CLIMATE CHANGE

Section Overview

So far the climate change problem has been discussed, but what sort of responses are needed to address this problem? This section briefly introduces mitigation and adaptation, the two main types of response to climate change.

Section Learning Outcomes

By the end of this section, students should be able to:

- describe mitigation and adaptation as the two basic forms of response to climate change challenges
- discuss critically major interactions between mitigation, adaptation, and development

4.1 Mitigation and adaptation: the basic concepts

What are the possible and desirable responses to climate change? What needs to be achieved, how, by whom, when, with what resources, and from whom?

Responses to climate change fall into two main types: mitigation and adaptation.

Mitigation

Mitigation involves actions reducing the emissions of greenhouse gases. Its aim is to reduce future climate change by slowing the rate of increase in (or even reducing) greenhouse gas concentrations in the atmosphere. It is defined by the IPCC as 'Technological change and substitution that reduce resource inputs and emissions per unit of output. Although several social, economic and technological policies would produce an emission reduction, with respect to climate change, mitigation means implementing policies to reduce GHG emissions and enhance sinks.' (Verbruggen 2007 p. 818).

Mitigation cannot stop climate change and climate change impacts from happening as (a) the greenhouse gases already released into the atmosphere will remain there for many years and (b) they will take many years to work through to some climate impacts, for example, the relatively slow absorption of heat by the oceans (from the atmosphere) means that global sea level rise is a slow process.

Increased climate change impacts must be expected in the future as a result of the delayed impact from greenhouse gases already released into the atmosphere and the continued release of greenhouse gases into the atmosphere in the future. Despite increasing concerns about climate change and recognition of the need for mitigation, greenhouse gas emissions continue to increase and governments face major challenges in agreeing on the necessary emissions reductions and on effective means of making such reductions. This makes adaptation, the other major response to climate, very important.

Adaptation

Adaptation involves adjustments that reduce (or aim to reduce) the negative human impacts of climate change. It is defined by the IPCC as 'Initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects. Various types of adaptation exist, for example, anticipatory and reactive, private and public, and autonomous and planned. Examples are raising river or coastal dykes, the substitution of more temperature-shock-resistant plants for sensitive ones, etc.' (Verbruggen 2007 p. 809).

Systems' or people's ability to adapt to a climate threat depends upon their adaptive capacity (the resources or assets – human, natural, social, and physical – available for adaptive responses) and the extent of adaptation required to eliminate, or reduce to an acceptable level, the adverse consequences of that threat.

The IPCC makes it clear that

- adaptation is necessary to address impacts of climate change as a result of inevitable warming due to past emissions
- adaptation cannot cope with anticipated climate change impacts in the future unless there is significant mitigation (a target of mitigation to prevent surface temperature rising more than 2 °C above pre-industrial levels is often taken to be a practical target, although this is not without risks and controversy)
- both adaptation and mitigation are needed and can be effective in a portfolio of measures to reduce the risks and threats associated with climate change

(IPCC 2007 pp. 19–20)

4.2 Linking mitigation and adaptation

It is clear that mitigation and adaptation are complementary responses to the threats posed by climate change. In this subsection, we explore these links a little further, in particular, relating them to vulnerability and to development.

Both mitigation and adaptation measures involve costs. The costs of action need to be compared with the costs of inaction. These costs will vary for different types of threats in different countries and locations and for different people. A key concept here is that of vulnerability.

Vulnerability

Vulnerability describes the extent to which individuals or societies are at risk of suffering damage from particular events or threats. Vulnerability depends upon the probability of a particular event actually occurring, the nature and severity of the event, and the nature and severity of the impact of that event on individuals or societies or the sensitivity of those individuals or societies to the event. Vulnerability to floods, for example, depends upon the likelihood of floods of different flood heights occurring, and the presence and effectiveness of flood protection dykes, the height of people's houses, the strength of people's houses, their dependence for food and income upon land and other assets susceptible to flooding, insurance mechanisms, the speed and effectiveness of government and other assistance, and so on.

Mitigation should reduce vulnerability by reducing the probability or likelihood of adverse climate change impacts, whereas adaptation may also reduce the likelihood of such impacts (not by reducing climate change but by limiting some impacts) as well as work to reduce the sensitivity to impacts.

✍ Can you think of ways in which adaptation may reduce the likelihood of climate change impacts and the sensitivity to such impacts?

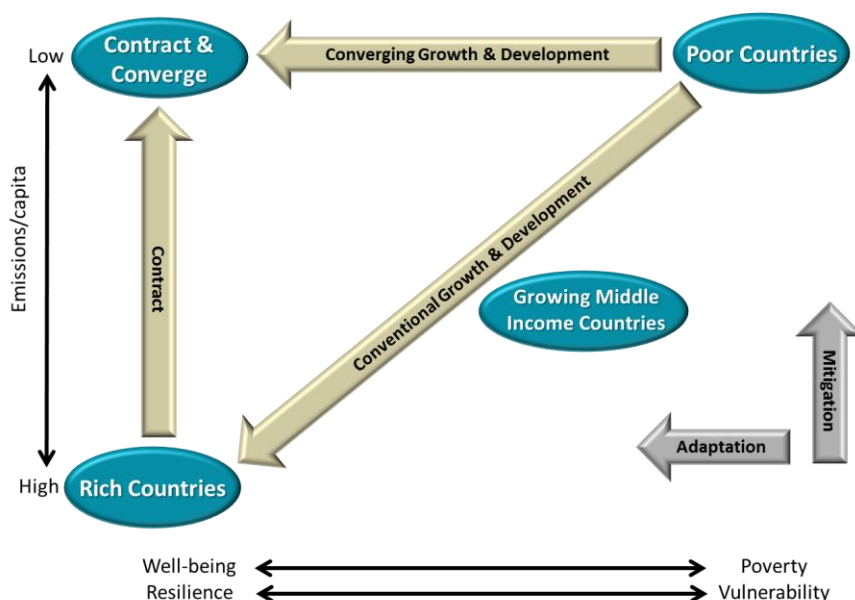
Answer.

Using the example of flooding above, upstream catchment management and physical works may reduce the likelihood of storms leading to down river floods. Investment in housing or relocation of housing to higher ground may reduce sensitivity to flooding. Alternatively, better early warning systems may give people more time to protect or escape with their assets, and rapid response and insurance systems may help them to lose less and to recover more quickly.

Mitigation, adaptation, and sustainable development pathways

Different countries and people and different activities have different mitigation potentials and costs, different vulnerabilities, and different adaptive capacities. It is unfortunate that the greatest mitigation potentials are normally associated with rich economies and people with lower vulnerabilities and higher adaptive capacities, whereas poorer people and economies tend to have lower emissions, higher vulnerabilities and lower adaptive capacities. This has important implications for development pathways, for climate negotiations, and for the welfare of poor people (see 4.2.1).

4.2.1 Mitigation, adaptation, and sustainable development pathways



Source: unit author

The figure in 4.2.1, above, shows a stylised representation of these relationships. This shows increasing poverty and vulnerability (and declining well-being and resilience) moving to the right along the horizontal axis. The vertical axis maps emissions per capita, with increasing emissions as you move down the figure. Countries can be mapped onto this. Most richer countries have higher emissions per capita, higher well-being and resilience, and lower vulnerability and poverty. They therefore tend to be located in the lower left of the diagram. Poorer countries, on the other hand, tend to be poorer, more vulnerable and less resilient, and to have lower emissions per capita. They are therefore situated towards the upper right corner of the diagram. Of course there will be activities and people within richer countries which are more vulnerable or poorer, and there will be activities and people within poorer countries with higher emissions or that are less poor and less vulnerable. Nevertheless, the diagram shows a valid general set of relationships, with growth traditionally leading to a trajectory from the top right corner of the diagram through the centre (where middle income economies are located) to the lower left corner.

Such a growth path is not sustainable in the context of climate change. Mitigation is shown by a movement of richer countries from the lower part of the diagram to the upper part of the diagram, and by a low emissions sustainable development growth path that involves countries moving horizontally from the upper right to the upper left of the diagram – as growth and development reduces poverty and vulnerability and increases well-being and resilience. The growth paths shown in the figure in 4.2.1 are compatible with the 'contract and converge' mitigation strategy advocated by Aubrey Myers of the Global Commons Institute, with richer countries making radical cuts in per capita emissions to contract emissions and converge with the current emissions per capita in poorer countries (GCI undated).

Increasing wealth is one way of increasing resilience and reducing vulnerability, specific adaptation measures are another, and these are therefore indicated as involving shifts to the left along the diagram. This recognises that, although there is a strong relationship between vulnerability and poverty on the one hand and resilience and well-being/wealth on the other, adaptation measures can help to reduce vulnerability even in the absence of poverty reduction.

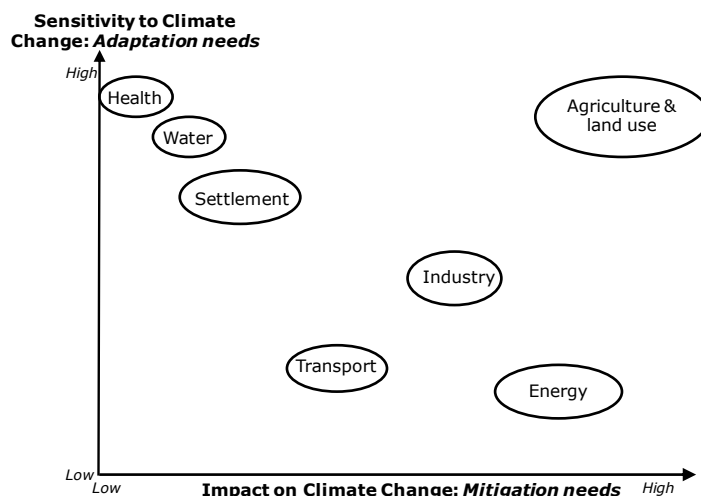
The diagram demonstrates strong linkages between sustainable development, poverty reduction, adaptation and mitigation, and suggests that development, which must be sustainable, is an important, indeed necessary, condition for climate adaptation.

Mitigation and adaptation in different sectors

Just as it is helpful to consider broad patterns of differences in mitigation and adaptation requirements between countries, it is helpful to consider such patterns across sectors of human activity. The figure in 4.2.2 locates sectors on the horizontal axis according to their **impact on** climate change, and on the vertical axis on their **sensitivity to** climate change (or the **impact of** climate change).

The characterisations of high and low sensitivities and contributions are of course extremely broad. Different types of agriculture, health, settlement, etc vary in both their sensitivities and contributions to climate change.

4.2.2 Sector contributions and sensitivities to climate change



Source: adapted from Gündel (personal communication)

It is possible to obtain broad figures on greenhouse gas emissions for the different sectors (see for example, McKeown and Gardner 2009 p. 190 which presents estimates of global sectoral emissions in 2004 and forms the basis for the arrangement in the figure in 4.2.2 regarding sectors' impacts on climate change), but different activities within each sector will have different impacts. Sensitivity to climate change is more difficult, varying with geographical location and type of activity. Complications also arise because of overlaps and interactions between sectors.



Can you think of examples of how impacts of and sensitivities to (impacts on) the different sectors may vary?

Answer.

Within agriculture and land use, deforestation is a major source of greenhouse gas emissions, as is livestock production (particularly some forms of more intensive livestock production). However, the planting of trees can be an important way of sequestering carbon. Agricultural sensitivity to climate change varies with the type of agriculture (for example, irrigated or rainfed crops) and its location (for example, between high and low latitudes, semi-arid or humid areas, and altitude). Fossil fuel energy production and transport have high emissions and impacts, but renewable energy and transport systems have much lower emissions and impacts – but may be more sensitive and vulnerable to climate change impacts. Energy and transport infrastructure in areas prone to flooding or storms may also be more sensitive to climate change impacts. The same applies to industry and settlement. Different industries also vary widely in their impacts on climate change – cement production, for example, is a particularly large emitter of CO₂. Sensitivities of water and health access and services to climate change also vary – by location, by wealth of people and infrastructure, and, in the case of health, by different types of health threat and disease.

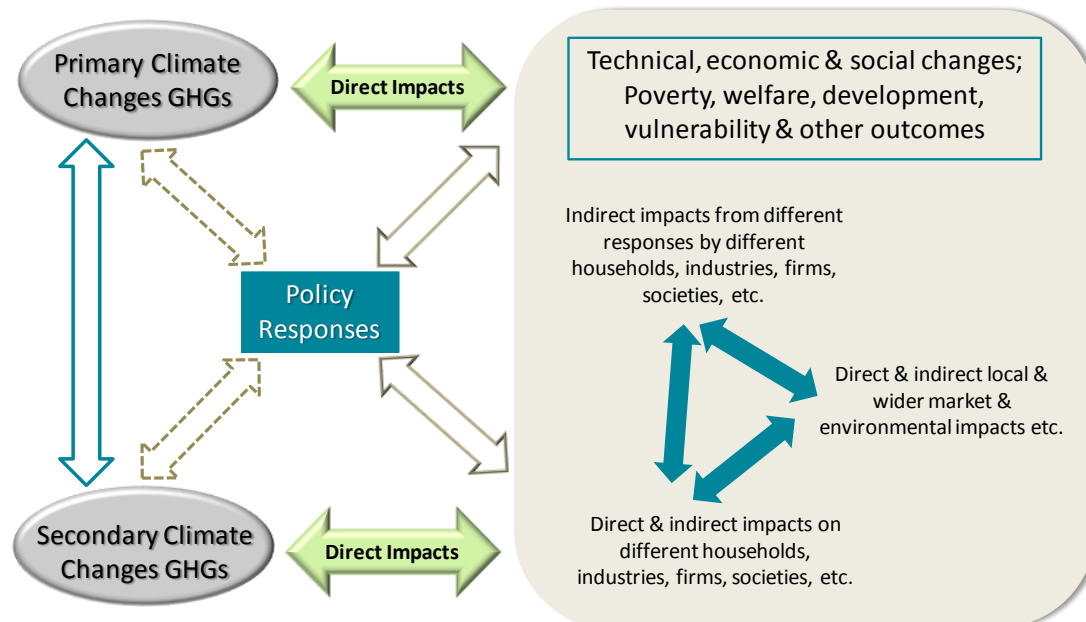
Interactions arise between sectors with regard to their impacts (for example, between the energy and agricultural sectors in agriculture's use of fertilisers and production of biofuels) and in their sensitivities (for example, between water access, agriculture, and health).

It is interesting to note the parallels and interactions between the two figures relating adaptation and mitigation in different countries (see 4.2.1) and in different sectors (see 4.2.2). Note that the high impact sectors of energy, transport, and industry are associated with or are more important in, more developed economies, whereas the high sensitivity sectors of health, water, settlement, and agriculture are important in all economies, but are **proportionately** more important in less-developed economies.

4.3 Secondary and indirect impacts of climate change and climate change responses

In considering mitigation and adaptation responses to climate change it is important to distinguish between primary and secondary climate changes, and direct and indirect impacts. These distinctions are often blurred and are not clear cut, but it is nevertheless helpful to consider them separately. The figure in 4.3.1 is intended to illustrate that the primary driver of climate change (greenhouse gas emissions and increasing greenhouse gas concentrations in the atmosphere) leads to a whole range of secondary climate and other impacts (as discussed in Section 1). The primary and secondary changes lead to direct impacts. These impacts, in turn, lead to indirect impacts from changes in human systems as people respond to changes as individuals, and these changes then affect markets, prices, values, and other variables.

4.3.1 Primary, secondary, direct and indirect climate changes and impacts



Source: unit author

Policy responses to climate change do not generally act directly on greenhouse gas emissions, the primary climate change: instead they may act on secondary climate changes or, most commonly, promote technical, economic, and social change which is, in turn, intended to reduce greenhouse gas emissions (mitigation) or to reduce climate change impacts (adaptation).

The complexity of the climate change problem and 'wicked' problems with climate arise because of the complexity (and uncertainty, scale, temporal, and distributional issues) in the relationships between

- greenhouse gas emissions (the primary climate change driver) and secondary changes
- secondary changes on the one hand and technical, economic, and social changes on the other
- the technical, economic, and social changes themselves

It was noted earlier that one feature of 'wicked' problems is that policy measures to address such problems often have unintended consequences. These arise as a result of unforeseen effects of policy changes as these policy changes 'work through', as people, social systems, and natural systems interact in their response to them.

It is important to note that if there are rapid policy changes to promote climate change mitigation (or indeed adaptation) then their effects will initially impact people more than climate change itself, sometimes negatively.

? Can you think of any examples of unintended consequences of climate change mitigation policies?

Answer.

Policies to subsidise and increase biofuels production in 2008 had a number of unintended consequences. Shifts of maize (corn) production to ethanol production in the US were one contributor to the food price spike in 2008, with very damaging impacts on food security. Biofuel incentives which led to the clearing of rainforest for oil palm production could actually increase greenhouse gas emissions with the release of carbon dioxide from the burning of biomass and the breakdown of soil organic matter. Of course there are questions about how far biofuel promotion is actually driven by concern to reduce greenhouse emissions rather than to support particular farming interest groups (Koplow 2006).

4.4 Political, lifestyle, and system interactions in climate change policy

The characteristics of climate change problems outlined in this unit suggest a number of reasons for difficulties in the design and implementation of climate change mitigation policies.

? Note down the principal difficulties that impede design and implementation of climate change mitigation policies.

Answer.

Externalities are one key problem: there is no direct connection between any particular individuals' or groups' greenhouse gas emissions and the negative impacts of those emissions. This is exacerbated by both

- the spatial separation of those who produce most emissions in richer countries from those who will experience the greatest negative impacts in poorer countries, and

- the temporal separation of those who produce most emissions now and from those who will experience the greatest negative impacts in the future

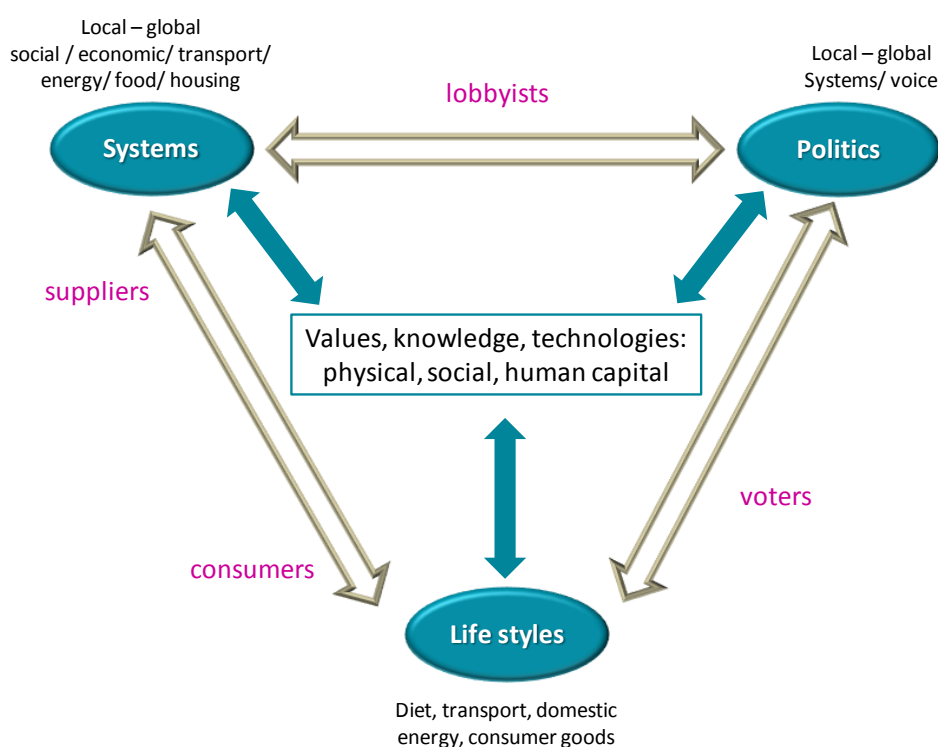
A further difficulty arises from the uncertainty about the nature and extent of climate change impacts, though this uncertainty is constantly declining as understanding of climate science and linkages between climate science and social science improves.

However, there is not just a problem of limited incentives for people and firms to invest in climate change mitigation, there are actual disincentives that lead to high costs for individual consumers, firms, and politicians (and governments). These disincentives arise as a result of '**lock in**' and **path dependency** which encourages continued development on existing high fossil fuel, high emission pathways. 'Lock in' is illustrated in 4.4.1.

We start by considering an initial situation with high fossil fuel consumption and high greenhouse gas emissions. Lifestyles (located at the bottom of the figure) based on fossil fuels may include the high use of petrol and diesel cars and of planes for personal and business transport, the high use of air conditioners and heating systems in homes and offices, and a diet with a high consumption of intensive livestock products, including a high proportion of beef and dairy products. Consumers with such lifestyles depend upon and demand highly developed systems (above and to the left in the figure) to supply the goods and services they need for their lifestyles. These systems – for example, transport, energy supply, food supply, tourism – are also based on high fossil fuel consumption and high greenhouse gas emissions. They have large investments in human, social, physical, and, in some cases, natural capital, and in the interactions between systems. It is in their short-term financial and economic interests to continue to supply fossil fuel-based goods and services as they have the skills, technologies, institutions, infrastructure, equipment etc to supply these, and they know that there is demand for these goods and services. It is also in their interests to encourage greater demand for their goods and services through marketing and technical innovation, and indeed to lobby

politicians for their government support for the fossil fuel-based economy. Politicians looking for political support then face pressure from system lobbyists and from voters who do not want to face uncertainties and possible, perceived higher costs in switching to a '**low carbon economy**'. These system and political interactions happen at global as well as national and sub-national levels. Underpinning all of this are the values held by societies, their knowledge, technologies, and other aspects of human, physical, and social capital. All of these have evolved and developed in the context of low fossil fuel prices.

4.4.1 Political, lifestyle, and system interactions in climate change policy



Source: unit author

The analysis of 'lock in' and path dependency presents a very pessimistic picture of a development pathway that is very difficult to change. However, it also suggests a variety of 'entry points' where changes are needed for the development of a 'low carbon economy'. There is also the possibility, with a complex system, of a sudden shift from a dominance of high carbon systems to a dominance of low carbon systems (see point 6 of 3.2.1 on complexity theory).

Section 4 Self Assessment Questions

Question 11

Fill in the missing words/phrases using the list below.

probabilities of impacts

GHG emissions

nature and severity

probability of particular events

impacts

sensitivity to impacts

- (a) Vulnerability describes the extent of risk of suffering or damage faced by individuals or societies. Vulnerability depends upon the _____, the _____ of those events, and the nature and severity of their _____ on individuals or societies.
- (b) Mitigation should reduce vulnerability by reducing _____ and hence the probability of adverse climate change events.
- (c) Adaptation should reduce vulnerability by reducing the _____ in spite of climate change and/or by reducing _____.

Question 12

Fill in the following missing words/phrases in the figure below.

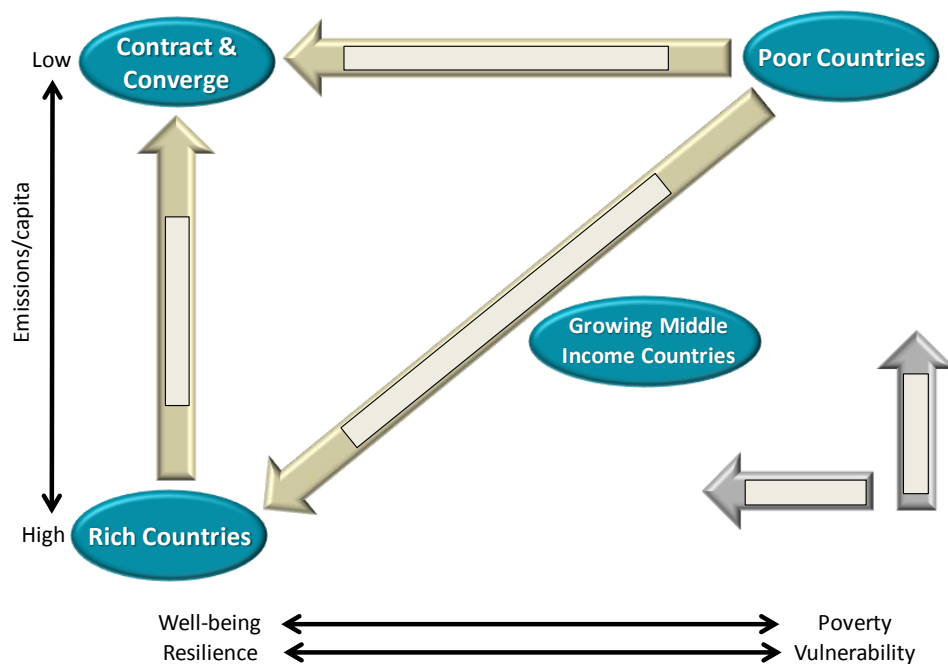
converging growth and development

adaptation

mitigation

conventional growth and development

contract



Question 13

Choose the correct definition for lock in.

- (a) 'Lock in' describes a situation where societies (individuals, firms, governments) have invested in infrastructure, technologies, and knowledge and other systems which relate to each other in particular ways, so that any introduction of different technologies faces extra costs in developing new infrastructure and skills for it to work effectively.
- (b) 'Lock in' describes a situation where societies (individuals, firms, governments) have invested in infrastructure, technologies, and knowledge and other systems which are totally independent, so that any introduction of different technologies can immediately be adopted with little difficulty.

UNIT SUMMARY

This unit has provided an introduction to the interactions between climate change and development and the potential for very serious impacts of climate change on development and poor people. Unfortunately, there are also very serious challenges to policies promoting mitigation and some forms of adaptation. Challenges in developing and implementing mitigation and adaptation policies arise from (a) path dependency locking political, economic, technological, and social systems into high GHG emissions, and (b) from the inherent complexity and 'wicked' nature of climate change problems. However, the unit identifies particular 'levers for change' which together may contribute to an escape from the current lock in and allow for possible shifts towards low carbon economies around the world.

Climate change and development are highly complex and involve understandings and tools from a wide range of disciplines and sectors. There are also major uncertainties which both increase climate change complexities and demand a critical questioning of claims about climate change impacts. Those who seek to work on or understand these issues better must have a broad and critical knowledge of climate change science, of the impacts of different sectors on and the sensitivity to climate change, and of generic and sector-specific mitigation and adaptation opportunities, difficulties, and achievements.

UNIT SELF ASSESSMENT QUESTIONS

Question 1

Section 1 discusses threats of climate change to development. From your reading of the unit as a whole, what are the threats that development poses to addressing climate change?

Question 2

List the features of climate change and of climate change impacts that make it so difficult to address.

Question 3

There is continued uncertainty about climate change processes and impacts due to our lack of understanding about them. How does this affect responses to climate change and what are the implications for professionals working on issues related to climate change?

KEY TERMS AND CONCEPTS

adaptation	actions that reduce the consequences of actual and expected changes in the climate
basic needs	an approach to development which stressed the importance of investments to provide people with secure access to food, shelter, water, and education and health services, often through community-based organisation
dependency	theory of development (or underdevelopment) that emphasises the role of unequal power relations between rich and poor economies in development processes, and the perpetuation of these unequal power relations to the benefit of rich economies
epistemological	concerned with the nature or basis of knowledge – epistemological uncertainty is uncertainty about the nature and status of knowledge on a particular topic – such as climate change
eutrophication	an increase in concentration of nutrients in an ecosystem (normally a water body) that leads to excess plant growth and decay which, in turn, disrupts the normal functioning of the ecosystem. In extreme cases in water bodies, the decay of organic matter leads to oxygen depletion which, in turn, affects the ability of different animal species to survive
externality	a cost or benefit arising from an economic action affecting other members of society but not directly affecting the actor responsible for that action. An externality can be positive or negative. Negative externalities are associated with activities in which the private costs are less than the social costs. Positive externalities are associated with activities in which the private benefits are less than the social benefits
global warming	an increase in the average annual global temperature at the earth's surface
greenhouse gases	gases that, when they occur in the atmosphere, inhibit the radiation of heat from the earth out of the atmosphere, and thus trap heat in the atmosphere
livelihood	a means of living; the capabilities, assets, and activities required for living; how people use what they have to meet their needs, and work towards their life objectives

lock-in	a situation where past investments in technology development, infrastructure, knowledge, skills, attitudes, and other requirements for (and parts of) energy, transport or other systems makes further investment in existing systems more profitable than investments in new systems. This is because further investment in existing systems builds on, and benefits from, previous investments. Investments in new systems lack the same 'critical mass' of previous complementary investments, lowering their returns and increasing the scale of investments needed. This 'locks' investors into continued investment in existing systems even though there may be other systems which have the potential to be more efficient and productive and to offer higher returns to investment once investment has reached the same scale. 'Lock in' is associated with path dependency
low carbon economy	an economy that meets people's needs with a low use of fossil fuels and low CO ₂ emissions
micro-finance	a system of providing financial services to poorer people who save and borrow very small amounts. Micro-finance systems generally use a combination of particular methods to lower transaction costs. These may include organisation of clients in groups, group liability, regular savings and repayments by group members, access to loans on a rotational basis
mitigation	actions that tackle the causes of climate change, such as reducing greenhouse gas emissions
modernisation	theory of development that posits a sequential growth process involving investment, technical change and increasing industrialisation
Neo-liberalism	an ideology of economic liberalism that emphasises the role of the private sector and markets (as against the role of the state) both in encouraging individuals to exercise freedom in the pursuit of their goals and in promoting economic efficiency in the attainment of those goals
non-linear relationships	relationships between two or more variables (for example, input and output) which are not linear, or do not follow the same pattern, over a range of values. The relationship over one range of values may not be a guide to the relationship over another range of values. Systems with non-linear relationships are likely to experience multiple equilibrium points, to be complex, and are difficult to model and predict
path dependency	where development options at any time are determined by (dependent on) previous choices and events. Closely associated with 'lock in'
political economy	the way that politics and economics interact. In particular, how those with political power may influence economic systems (and vice versa), such that political behaviour and economic structures and processes need to be considered together

public–private partnerships	formal arrangements where the state contracts with private companies to provide certain services on behalf of the state. These arrangements are intended to allow the state to call on extra resources available to private companies (including finance and expertise) and/or allow more efficient provision of services by private sector organisations
rights-based approaches	approaches to development where access to basic needs and services is seen as a human right, and the state has a duty to ensure that rights are met
social protection	a stream of development that emphasises the provision of resources and services to protect and promote the welfare of poorer and more vulnerable members of society
spillover effects	a form of externality where if one or more individuals or firms engage in an activity then this leads to the local development of capital (for example, human capital in skills, social capital in institutions, physical capital in infrastructure) from which other firms engaging in the activity can benefit
sustainable livelihoods	an approach to development that emphasises development of people's livelihoods in ways that are sustainable and reflect and build on people's own aspirations and understandings of their resources, activities, vulnerabilities, opportunities, and constraints
tipping points	where climate changes lead to a qualitative or structural change in the climate system which prevents (or at least hinders) movement back to the previous equilibrium. An example of a possible tipping point is the loss of sea ice or snow cover leading to reduced reflection and increased absorption of solar radiation. If this then promotes global warming to the extent that this leads to further snow or ice melt, then a tipping point has been reached
uncertainty	an expression of the degree to which a value is unknown (eg the future state of the climate system). Uncertainty can result from a lack of information or from a disagreement about what is known or even knowable. It may have many types of sources, from quantifiable errors in the data to ambiguously defined concepts or terminology, or uncertain projections of human behaviour. Uncertainty can therefore be represented by quantitative measures (eg a range of values calculated by various models) or by qualitative statements (eg reflecting the judgment of a team of experts) (Verbruggen 2007 p. 821)
vulnerability	susceptibility to harm as a result of both exposure and sensitivity to potentially damaging shocks and stresses